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(54) Title: GAS FIRED PORTABLE UNVENTED INFRARED HEATER

(57) Abstract: A portable heater adapted for use in a recreational enclosure or temporary work enclosure includes a housing having an air inlet on the lower front face. A gas supply is at least partially enclosed by the housing which provides propane to the mouth of a burner venturi located within the housing. Air is drawn through the air inlet and also enters the mouth of the burner venturi. The air and gas are mixed thoroughly as they travel upwardly through the burner venturi. A chimney effect increases fresh air flow velocity into the burner venturi and allows the heater to operate at a reduced fuel gas pressure. Upon exiting the burner venturi, the air/gas mixture is to a plenum and radiant surface where combustion takes place. Any conventional means may be provided to ignite the air/gas mixture in order to cause combustion. The combustion products deflect off a deflector, which is cooled on a rear face by air flow through the housing, which decreases the temperature of the combustion products before exiting an outlet. An oxygen depletion system (ODS) shuts off the portable heater when oxygen levels begin to drop and consequently carbon monoxide levels begin to rise.

PCT/US04/032071 / Gas Fired Portable Unvented Infrared Heater

2 Cross-Reference to Related Applications

3 This application is a continuation-in-part of United States Patent Application
4 Serial No. 10/605,486, filed October 2, 2003, which is a continuation-in-part of United
5 States Patent Application Serial No. 10/051,561, filed January 18, 2002, which is a
6 continuation application of United States Patent Application Serial No. 09/731,156, filed
7 on December 6, 2000, now United States Patent No. 6,340,298, which is a non-
8 provisional patent application of United States Patent Application Serial No. 60/169,062,
9 filed December 6, 1999.

10 Technical Field

11 This invention relates generally to improved portable heaters used in relatively
12 small enclosures. More particularly, the invention relates to a uniquely configured
13 propane source infrared heater for use in enclosures such as small recreational
14 enclosures, temporary work enclosures, or vehicles. Although the invention was
15 designed for indoor areas, it will be appreciated that it has broader applications and may
16 be advantageously employed in a wide variety of environments without departing from
17 the scope of the invention.

18 Background of the Invention

19 Gas-fired portable heaters are well known in the art and are used in multiple
20 environments. The heater typically includes a housing having a chamber. The housing
21 has an inlet for receiving air into the chamber. Gas is introduced into the chamber to be
22 mixed with the air in order to complete combustion and provide an infrared heating
23 surface. A plenum directs the heat toward a mesh screen and evenly distributes it over
24 the surface thereof. The overall goal in designing such a unit is to achieve a radiant
25 surface that provides even, stable heating over the entire surface.

26 The use of such heaters is strictly regulated for outdoor only use due to the
27 emission of carbon monoxide. Prior designs in existing portable units are subject to a
28 wide variety of problems. Most importantly, the prior designs are not safe or certified to
29 operate in small recreational enclosures such as tents, truck-caps, fishing huts, trailers,
30 vans, etc. There are a few reasons why the devices found in the prior art are not
31 adequate to perform in such environments. First, the portable heaters that exist today
32 operate at a high pressure generally on the order of 12 psi. Specifically, the pressure
33 from the propane tank through a regulator is necessarily high in order to achieve
34 adequate gas and air flow. In addition to requiring high pressure, previous designs do
35 not have the ability to pass strict combustion requirements at a high and low firing

1 ~~reconditioned at a reduced pressure.~~ For example, a new standard developed for this
2 product (CSA International 4.98 US) states that "the appliance shall not produce carbon
3 monoxide in excess of 0.010 (100 ppm) percent in a room with no air changes occurring
4 during combustion of the amount of gas necessary to reduce the oxygen content of the
5 room to 18 percent by volume." In addition, they do not possess an oxygen depletion
6 system ("ODS") (Capreci/Part No. 21500). These shortcomings have prevented the
7 portable heaters found in the prior art from adequately performing in small recreational
8 and temporary work enclosures.

9 Therefore, a need exists to provide a portable infrared heater capable of
10 performing safely in small recreational enclosures and temporary work enclosures.

11 ***Summary of the Invention***

12 This Invention contemplates a new and improved burner assembly that is capable
13 of performing safely in small recreational facilities such as tents, truck-caps, vans,
14 fishing huts, trailers, etc.

15 According to the present invention, a portable heater includes an outer housing
16 having a first or front face, a second or rear face, and two sides interconnecting the front
17 and rear faces. An air inlet is located on the front face of the housing, preferably along a
18 lower portion thereof. A gas supply or tank is partially enclosed and supported by the
19 outer housing. A burner venturi, having a cylindrical body extending upwardly at a slight
20 angle, is disposed within the housing. The burner venturi also has a mouth operatively
21 associated with a bottom end of the cylindrical body. Gas is released from the gas
22 supply into the mouth of the burner venturi. At the same time, air is drawn into the
23 mouth of the burner venturi from the air inlet. The air and gas mix thoroughly as they
24 travel upwardly through the burner venturi.

25 Upon exiting the burner venturi, a baffle directs the air/gas mixture into a plenum
26 to further mix, enter a rear face of a radiant surface, and then ignited on a top surface
27 where combustion occurs. Any conventional means for initially sparking or igniting the
28 air/gas mixture at the burner surface can be used. The burner plenum is heated to an
29 elevated temperature and the radiant surface emits heat to the ambient environment.
30 Combustion products are directed off a deflector shield which reduces the temperature
31 of the products before exiting an outlet at an upper portion of the housing.

32 The air inlet of the present invention is advantageously designed to provide air
33 flow along the hot burner plenum resulting in an increased velocity of air flow to the
34 burner venturi. As the burner venturi is heated, the thermal properties result in the
35 air/gas mixture passing upwardly through the angled burner venturi creating a chimney

1 ~~It type effect~~ The chimney effect created by the present invention increases the air flow
2 velocity into the burner venturi. In addition, the device reduces pressure from the gas
3 supply and has the ability to satisfy combustion requirements at low fire condition.

4 These and other objects of the present invention will become more readily
5 apparent from a reading of the following detailed description taken in conjunction with
6 the accompanying drawings wherein like reference numerals indicate similar parts, and
7 with further reference to the appended claims.

8 ***Brief Description of the Drawings***

9 The invention may take physical form in certain parts and arrangements of parts,
10 a preferred embodiment of which will be described in detail in the specification and
11 illustrated in the accompanying drawings which form a part hereof, and wherein:

12 FIG. 1 is a perspective cross-sectional view of a heater assembly in accordance
13 with the teachings of the present invention;

14 FIG. 2 is a longitudinal cross-sectional view of the heater assembly in accordance
15 with the present invention;

16 FIG. 3 is an enlarged elevational view of a thermocouple, spark igniter, and pilot
17 tube assembly used in the preferred embodiment of the present invention;

18 FIG. 4 is a perspective view of the heater taken generally from the front and left-
19 hand side;

20 FIG. 5 is a perspective view of the heater taken generally from the front and right-
21 hand side;

22 FIG. 6 is a perspective view of the heater taken generally from the rear and right-
23 hand side;

24 FIG. 7 is a perspective view of the heater taken generally from the rear and left-
25 hand side;

26 FIG. 8 is a perspective elevational view of the heater in accordance with the
27 present invention;

28 FIG. 9 is a bottom view of the portable heater;

29 FIG. 10 is a side elevational view of the portable heater;

30 FIG. 11 is a side elevational view of the portable heater;

31 FIG. 12 is a rear elevational view of the portable heater;

32 FIG. 13 is a front elevational view of the portable heater;

33 FIG. 14 is a top view of the portable heater;

34 FIG. 15 is a side elevational view of the portable heater showing a fully enclosed
35 fuel source openable by a hinged door;

1 PCT/FIG. 36 is front elevational view of the portable heater showing an attached
2 battery pack for use with an optional fan to increase circulation;

3 FIG. 17 is a top perspective view of the portable heater with top handle removed
4 showing an optional rear fan in the housing operated by removable and optionally
5 rechargeable dry cell batteries;

6 FIG. 18 is a rear elevational view of the portable heater showing a detachable
7 door for enclosing the fuel source;

8 FIG. 19 is a rear elevational view of the portable heater with the detachable door
9 of FIG. 18 removed thereby illustrating the fuel source which is pivotable about a fuel
10 supply connection;

11 FIG. 20 is a top elevational view of the portable heater with handle and front grill
12 removed showing two fuel sources positioned about one side of the heater;

13 FIG. 21 is a front elevational view of the portable heater of FIG. 20 showing front
14 fuel source in ghost lines;

15 FIG. 22 is a top elevational view of an alternative embodiment of the invention
16 illustrating two fuel sources positioned about opposed sides of the heater;

17 FIG. 23 is a front elevational view of FIG. 22 illustrating the fuel sources enclosed
18 within a slotted enclosure;

19 FIG. 24 is a top elevational view of an alternative embodiment of the invention
20 with handle and front grill removed illustrating two fuel sources positioned at the rear of
21 the heater and partially protruding through the rear wall of the heater;

22 FIG. 25 is a front elevational view of FIG. 24;

23 FIG. 26 is a rear perspective view with rear and side panels removed illustrating
24 pivotable fuel source rotation and battery-powered fan;

25 FIG. 27 is a bottom perspective view illustrating the optional remote LP gas
26 supply house in a coiled configuration;

27 FIG. 28 is a side perspective view of an alternative embodiment for the
28 attachment of two fuel regulators illustrating a sliding track arrangement for the fuel
29 regulator connection in conjunction with a flexible braided hose, the heater housing
30 having the enclosing shroud or enclosure removed;

31 FIG. 29 is a side perspective view of an alternative embodiment of a portion of
32 the portable heater illustrating a fixed fuel regular positioned within the pivotable door of
33 the housing in conjunction with a flexible braided hose;

34 FIG. 30 is a side perspective view of an alternative embodiment of the
35 attachment for the fuel regulator illustrating a movable fuel regulator attached by a

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21 the heater and partially protruding through the rear wall of the heater;

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26 supply hose in a coiled configuration;

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33 the housing in conjunction with a flexible braided hose;

34 FIG. 30 is a side perspective view of an alternative embodiment of the
35 attachment for the fuel regulator illustrating a movable fuel regulator attached by a

1 ~~Flexible hose with a clip arrangement within the housing for cylinder positioning and~~
2 retention;

3 *FIG. 31* is a side perspective view of an alternative embodiment of the fuel
4 regulator affixed in the heater housing illustrating a hinged pivotable bracket within
5 which is fixedly positioned a fuel regulator in conjunction with a flexible braided hose;

6 *FIG. 32* is a side perspective view of an alternative embodiment of the fuel
7 regulator illustrating a pivotable weighted clip; and

8 *FIG. 32a* is an enlarged side perspective view of the rotating clip of *FIG. 32*; and
9 *FIG. 33* is an enlarged cross-sectional view of a pivotable regulator.

10 **Detailed Description of the Invention**

11 Referring now to the drawings wherein the showings are for purposes of
12 illustrating the preferred embodiment of the invention only and not for purposes of
13 limiting the same, the Figures show a portable heater for use in confined spaces with
14 various configurations for the positioning of the fuel source(s).

15 Referring now to the drawings wherein the showings are for purposes of
16 illustrating the preferred embodiment of the invention only, and not for purposes of
17 limiting same, the FIGURES show a portable heating device A adapted for use in small
18 enclosed environments. Although the present invention is designed for use in
19 recreational enclosures and temporary work enclosures, it will be appreciated that other
20 uses are contemplated.

21 The portable heater A includes a housing 10 having a front face 12, a rear face
22 14, and two sides 16, 18. The housing 10 is preferably manufactured to have smooth
23 contours to prevent snagging or catching of things such as clothing, fabric, etc. A
24 stepped recess or external cavity is formed in an upper front corner region of the left
25 side 16 of the housing 10 for supporting a control knob or temperature controller 20.
26 The recess provides protection against inadvertent contact and accidental changing of
27 the temperature. The temperature controller 20 preferably has four positions: off, pilot,
28 low, and high (not shown) although continuously variable positions for infinitely variable
29 heating is also contemplated within the scope of this invention. Controller may
30 incorporate a piezo spark igniter integral to controller stem rotation.

31 Another recess is disposed on the upper back corner of the left side 16 of the
32 housing 10. This recess supports an igniter button 22 for activating the heater A. This
33 recess also protects against inadvertent contact with the igniter button 22.

34 The heater A is supported by two elongated legs 24a, 24b laterally disposed
35 along the outboard edges of the rear face 14 and front face 12 respectively. The legs

1 **FIGS. 24a, 24b** show preferably grooved providing a friction surface to contact the supporting
2 surface and preferably extend over the entire width of the housing to provide a wide
3 "footprint" and stable support area for the heater. In another embodiment (not shown),
4 additional legs extending front to rear are provided beneath legs 24a, 24b to increase air
5 flow beneath the heater. A handle 26 is recessed from and extends from the top of the
6 heater at an angle directed away (approximately 15°) from the front face 12. The offset
7 allows the handle to remain cool for handling by a user while the angled orientation of
8 the handle 26 protects the user's hand from heat exiting the top of the heater while the
9 user transports the heater. The handle 26 is optionally grooved providing an enhanced
10 gripping surface for the user.

11 A shield or metal grid 30 is attached to the front face 12 of the heater to provide
12 protection to the heater components. In addition, the shield prevents accidental contact
13 with the hot portions of the heater front face 12. The shield is preferably made from
14 elongated wire metal strips and peripheral pieces are received in openings 32 in the
15 housing to secure the shield to the heater. In addition, only one screw (not shown) need
16 be removed for access to the interior components enabling easy servicing or
17 replacement of selected components of the heater. Two keyhole openings or recesses
18 34a, 34b are located on the upper portion of the back face 14 of the heater allowing the
19 user to hang the heater in an elevated position.

20 An opening or air inlet 40 is disposed on a lower portion of the front face 12 of the
21 heater for receiving and filtering air drawn into the housing. The air inlet 40 is preferably
22 formed from a series of elongated slits 42 equispaced across the housing beneath the
23 shield. However, any opening that adequately provides air inflow is within the scope of
24 the present invention.

25 An LP ("Liquified Petroleum" or "Liquified Propane") gas supply tank 50 is
26 secured to and partially enclosed by the housing 10 (See FIGS. 5 and 6). The LP gas
27 supply 50 is preferably a removable canister or propane tank that can be replaced by a
28 new tank or removed, refilled, and re-installed in the housing. A conical dome 52
29 protrudes from the side 18 of the housing 10 and partially encloses the gas supply tank
30 50. The dome acts as a protective shroud to cover the interconnection of the tank with
31 the housing. For example, a one pound propane cylinder may be connected to the
32 housing to provide approximately six hours of continuous operation on the low setting.
33 Alternatively, the heater can be supplied, for example, by a conventional twenty pound
34 propane tank having an extended length hose assembly so that the tank can be located
35 away from the heated region. For instance, the propane tank can be positioned outside

1 Patent, cabin, fishing shanty garage, etc. while the heater is located within the structure
2 and the heater provide on the order of one hundred and ten hours of heat with the larger
3 gas supply tank.

4 The gas supply 50 is connected to a regulator which connects to a valve and
5 orifice 56 (See FIG. 1) which is selectively adjustable between open and closed
6 positions, access being provided to the regulator through window opening 58 for remote
7 LP gas supply hose tightening and leak checking (see FIG. 6). Optionally the LP gas
8 supply hose 130 with connector fittings 132, 134 is stored underneath the unit within
9 receptacles 136 in combination with side ledges 138 illustrated in FIG. 27. It is
10 recognized that the LP couplings may be "quick connects" when the supply pressure is
11 already regulated to about 11" water column. In this embodiment, the quick-coupler
12 hose is integral to the heater and downstream from heater regulator(s) but before the
13 control valve to facilitate connection to a regulated hose supply from an external fuel
14 source such as a 20 pound cylinder. Similarly, the regulated fuel supply (11" water
15 column) could originate from a self-contained system as in a recreational vehicle. The
16 quick-coupler hose connection would incorporate positive fuel shut-off in both male and
17 female connection components to prevent fuel escape when disconnected.

18 Referring again to FIGS. 1 and 2, a burner venturi 60 is enclosed within the
19 housing 10 and operates to mix oxygen and propane for combustion. The burner
20 venturi 60 has a hollow generally cylindrical body 62 and a tapered mouth 64 having a
21 wider diameter than the body 62. The burner venturi is disposed at an angle α relative
22 to the longitudinal axis of the heater A. The mouth 64 of the burner venturi is positioned
23 on approximately the same axial plane as the air inlet 40 and the cylindrical body 62
24 extends upwardly from the mouth 64. The orifice 56 which is attached to the gas supply
25 50 is located directly beneath the mouth 64 of the burner venturi 60.

26 Also located within the housing A is a generally planar radiant surface 70
27 disposed at an angle α relative to the longitudinal axis of the heater. A rear face of the
28 radiant surface is in communication with a cavity or plenum chamber 72. The burner
29 plenum receives the air/gas mixture from the venturi and distributes the mixture over
30 and through the rear face of the radiant surface. Thus, in operation, the orifice 56,
31 attached to the gas supply, is opened releasing a fuel gas such as propane into the
32 mouth 64 of the burner venturi 60. Associated with the orifice is a regulator that reduces
33 the delivery pressure of the fuel gas from the tank (rated up to 150 psi) to eleven inches
34 of water column in one stage. Thus, this portable heater operates at a significantly
35 lower pressure than existing commercially available units. The stream of gas exiting the

1 ~~Creates a vacuum effect drawing air from the air inlet 40 into the mouth 64 of~~
2 the burner venturi. Propane and air are thoroughly mixed in the burner venturi 60 and
3 plenum 72 in order to achieve complete combustion and produce a clean burning
4 infrared heating surface. The mixture of oxygen and propane travels upward through
5 the cylindrical body 62 of the burner venturi 60 until reaching the plenum chamber 72.
6 To prevent the mixture of propane and oxygen from immediately exiting the plenum
7 chamber 72, a solid baffle 76 is provided which forces the air/gas mixture downward into
8 communication with the rear face of the radiant surface.

9 The radiant surface may be a burner tile or a multi-ply screens (not shown) that
10 define a plurality of small openings which permit combustion of the air/gas mixture as it
11 passes therethrough. A means is provided for initially sparking or igniting the mixture at
12 the radiant surface. In the present invention a container 80 houses the pilot 82 and the
13 igniter 84 (see FIG. 3) which provides the initial sparking. It will be appreciated that any
14 conventional means for initially sparking or igniting the mixture can be utilized.
15 Combustion of the air/gas mixture is maintained and reaches elevated temperatures of
16 approximately 1200° F. The heater shown in the drawings with one propane cylinder is
17 rated at a minimum 4000 BTUs and a maximum 9000 BTUs at eleven inches water
18 column pressure. Other ratings are also potential alternatives, including up to 20,000 to
19 25,000 BTU models when more than one propane cylinder and associated burner
20 assemblies are utilized.

21 A reflector 90 extends outwardly from the top of the burner plenum 72 at an angle
22 directed toward the top portion of the front face 12 of the housing 10. The natural
23 convective upward path of the combustion products leads the combustion products into
24 contact with the reflector 90. The reflector 90, in addition to directing the radiant energy
25 output from the heater toward the front surface of the housing, also acts as a deflector
26 and reduces the temperature of the combustion products exiting the heater which
27 greatly reduces the chance for ignition of a combustible material if it comes into contact
28 with the heater A. An outlet 92 is disposed near the top of the housing 10 allowing
29 warm air to mix with combustion products and exit the device after contacting the
30 reflector 90. In addition, a deflector 95 is disposed on the top of front face 12 which
31 reduces the temperature of the combustion products exiting the heater which greatly
32 reduces the chance for ignition of a combustible material if it comes into contact with the
33 heater A.

34 In addition, there is an outlet or grate 94 disposed rearward of outlet 92 that
35 communicates with the interior of the housing. It provides a continuous flow path for air

1 ~~(that does not enter the venturi)~~ to flow from the inlet 40 around the rear of the plenum
2 chamber and exit the housing rearward of the deflector. This enhances the chimney
3 effect as described above since a large amount of ambient air is drawn into the housing,
4 a portion used for combustion purposes and the remainder convects upwardly along the
5 rear of the plenum and the deflector to exit via the openings 94. The air inlet 40 of the
6 present invention is designed to encourage air flow along the back of the hot burner
7 plenum 72, advantageously resulting in an increased velocity of air flow to the burner
8 venturi, as well as cooling the rear housing 10. As the burner venturi 60 is heated, the
9 thermal convection properties urge the air/gas mixture through the upwardly angled
10 burner venturi 60 creating a chimney type effect. The chimney effect created by the
11 present invention increases the fresh air flow velocity into the burner venturi, enabling
12 the pressure from the gas supply 50 to be reduced, yet burn efficiently on high or low
13 settings.

14 In addition to housing the pilot 82 and the igniter 84, the container 80 preferably
15 houses an oxygen depletion system (See FIG. 3). The oxygen depletion system (ODS)
16 provides an automatic shutoff mechanism when decreased oxygen levels and resulting
17 increased carbon monoxide concentrations are detected. For example, the heater of the
18 present design is intended to automatically shut off at 100 PPM of carbon monoxide at
19 18% oxygen levels (21% free normal air). A thermocouple 86 monitors changes in
20 temperature of the pilot flame which indicates changes in oxygen and carbon monoxide
21 levels. Previous designs found in the prior art use a thermocouple/plunger type safety
22 shut-off arrangement, which is not deemed to be as sophisticated or precise as the ODS
23 of the present invention. The addition of an ODS to portable unvented heaters is an
24 improvement in the art and the first of its kind. A more detailed discussion of the ODS
25 can be found in a variety of resources.

26 The present invention significantly reduces the pressure from the propane tank in
27 one stage. The pilot burner must operate at 11" water column (W.C.) while the main
28 burner may optionally operate at this same pressure although higher pressures are
29 envisioned. This is the first portable device for indoor use that the applicant is aware of
30 that conforms to this standard. The portable heaters that exist today all operate at high
31 pressures (on the order of 12 psi) and do not incorporate an ODS. In addition, the
32 present device has the ability to pass combustion requirements at a low fire condition.

33 In another embodiment of the invention illustrated in FIG. 15, the fuel source is
34 positioned within housing 10 and is accessible through pivotable hinged door 100 with
35 latch 102. Conical dome 52 extends partway down vertical side 18 and over at least a

1 portion of the valve or fuel supply 50. Pivotal movement of hinged door 100 is
2 accomplished by the user effecting vertical axial counterclockwise rotational movement
3 about a pair of hinges or pivot axis (not shown) at one side of the door.

4 FIG. 17 illustrates yet another embodiment of the invention in which improved air
5 flow is effected through heater unit A by the incorporation of a paddle or cage fan 110 in
6 back panel 14. In one aspect shown in FIG. 16, a rechargeable battery pack 104 is
7 illustrated to be positionable within accommodating slot 116 within side panel 16 of
8 housing 10. Knob 106 is used to variably define the power setting used with battery
9 pack 104 as well as to be used as an "on/off" switch for controlling the speed of fan 110.
10 Alternatively, and in another aspect of the invention, at least one, preferably two or more
11 rechargeable dry cell batteries, 108a, 108b are employed within side panel 16 of
12 housing 10 as better illustrated in FIG. 17. The batteries are positioned to be loaded
13 from the bottom of housing 10 and, the power controlled by a variably positioned knob
14 106 located toward the front of housing 10 or at an alternative position as is known in
15 the art for controlling variable amounts of power to an electrical device. Depending on
16 the rotational speed of the fan desired, coupled with battery life expectancy, anywhere
17 from one to four "C" or "D" sized batteries are employed, although it is equally
18 envisioned that "AA" batteries may be used in some models where power consumption
19 is envisioned to be minimal or usage infrequent and for short duration. Fan 110 has a
20 plurality of paddles or inwardly extending panels for creating air movement through
21 rotational pivotal movement about axis 114. The fan is typically a lower voltage fan,
22 e.g., 3.0 volts, powered by a direct current motor. This increased air flow insures
23 maximal cooling capacity on various metal and plastic components in heater A. Battery
24 operation is also illustrated in FIG. 26 where an alternative dry cell location is identified.

25 FIGS. 18-19 illustrate another embodiment of the invention in which a snap-fit
26 door 100 is removable from side panel 18 thereby permitting pivotal rotational
27 movement from a first position to a second replaceable position of fuel source 50 by
28 swivel fitting 120. This configuration allows an end-user to rotate the fuel source for
29 easier canister replacement without having to simultaneously lift the unit. This pivotal
30 coupling is additionally illustrated in FIG. 26 where one fuel source 50 is shown rotated
31 approximately 90°. Pivotal movement is effected by rotatable fuel supply connection
32 120 feeding common fuel line 115. Propane cylinders are secured by threading
33 engagement with regulator 119 held in position by sheet metal bracket 117 with pivot
34 axis. FIG. 33 better illustrates a Prior Art swivel gas connector, one commonly found for
35 example, on heating products and in particular, propane gas grills for outdoor use for

1 ~~about the past ten years.~~ The Figure illustrates a gas regulator 119 pivotable about an
2 axis. Rotation is effected circular movement of cylindrical rod 174 within the apertures
3 of U-shaped channel bracket 172 in conjunction with similar movement of gas exit port
4 176 sealingly engaged with the regulator at one end and sealingly engaged about its
5 circumference at an opposed end by a pair of sealing O-rings 166. Gas exit port is held
6 in place through set screws 168 which penetrate into an annular groove positioned
7 about the circumference of the gas exit port. U-shaped channel bracket 164 secures
8 the gas exit port into the frame of the portable heater.

9 FIGS. 20-27 illustrate yet another embodiment of the invention in which more
10 than one fuel source is positionable within the housing. As illustrated in FIG. 20, two
11 fuel sources 50a, 50b are positioned within side wall 18 and at least partially covered by
12 dome-shaped shoulders, and in one aspect, completely enclosed therein as illustrated in
13 FIG. 21. Temperature controller button 20 and igniter button 22 are positioned similarly
14 to that shown previously in FIG. 4.

15 In FIGS. 22-23, two fuel sources 50a, 50b which are at least partially enclosed by
16 dome-shaped side panels 52a, 52b are positioned on opposed sides 18, 16 of heater
17 housing 10. In this particular embodiment, the units are connected by a mixing valve
18 (not shown) and the temperature controller button 20 and igniter button 22 operate to
19 control a single burner unit.

20 In FIGS. 24-25, two fuel sources 50a, 50b are once again shown, the canisters
21 protruding at least partially from the rear 14 of heater housing 10. As illustrated in this
22 embodiment, each fuel source has its individual temperature controller buttons 20a, 20b
23 and igniter buttons 22a, 22b for controlling the temperature of heater A.

24 It is recognized that when dual fuel source applications are discussed, it is
25 recognized that the heat capacity of each burner need not be the same, and it is within
26 the scope of this invention that different capacity burners are envisioned. For maximum
27 heat control by the end-user, it is within the scope of the invention that one burner will
28 be for "low" capacity applications and wherein the second burner will be for "high"
29 capacity applications, and wherein the two burners can be used in combination to
30 produce yet a higher capacity unit. For other applications, there will be two "low"
31 capacity burners employed within one unit as well as applications where there will be
32 two "high" capacity burners employed within the same unit. Optionally, there are
33 applications wherein each burner (if each burner has a separate control) or a combined
34 controller where each burner is commonly controlled) will have an associated "low",
35 "medium" and "high" setting to permit still further refinements in the heat provided by the

1 Device / Additionally, it is envisioned that the heating device will have a single controller
2 and one burner, the controller / burner combination having "low", "medium" and "high"
3 settings. In a more expensive version of the heater, two continuously variable burners
4 will be employed, such variability predicated by the rate at which fuel and/or air is
5 supplied to the burners as well as the capacity of the burners, although it is envisioned
6 that a single continuously variable burner is within the scope of this invention.

7 It should be noted that in embodiments of this invention in which more than one
8 fuel source is illustrated, that the fuel sources can either be operated in tandem or
9 individually. When operated in tandem, a mixing valve is included prior to the burner. In
10 some embodiments of the invention, the second location of the fuel source is that of a
11 storage capacity only, and the unit operates as previously described. It should also be
12 noted that the handle 26 illustrated in many of the embodiments, is often optional, and
13 that a heater which achieves portability by the incorporation of wheels 120 positioned at
14 the bottom of the unit, better illustrated in FIG. 25 is within the scope of this invention or
15 wherein the portability is associated with the incorporation of a wheeled dolly-like
16 apparatus. When the wheels are of fairly small size, the number of wheels is at least
17 three, preferably four and they are pivotable about a vertical axis. When the number is
18 three, the wheels are positioned in a triangular fashion with two wheels at opposed ends
19 on one side, and a third wheel in the middle of the unit on an opposed side. When the
20 number is four, the wheels are positioned at the vertices of the base of the unit. In a
21 specialized configuration, the number of wheels can be reduced to two. When used in
22 this manner, the wheels are more similar to rollers and occupy at least 50% of the width
23 of the base, preferably more and extending essentially across a complete side, on both
24 sides of the unit.

25 Alternative embodiments of the modes of attachment of the regulator are
26 illustrated in FIGS. 28-32. FIG. 28 illustrates an alternative embodiment of the swivel
27 gas connector illustrated in FIGS. 26-27 and 33 and shows slide channels 140, 142
28 which contain sliding regulator brackets 152 into which are positioned gas regulators
29 119. Flexible gas hose 148 and associated regulator fitting 146 and gas line fitting 150
30 to secure interconnection between the fuel supply (not shown) and the burner assembly.
31 A convenient pull-tab 144 is optionally incorporated into each regulator bracket 152.

32 Fig. 29 illustrates yet another alternative embodiment to the swivel gas connector
33 in which pressure regulator 119 swings out through its fixed positioning within bracket
34 154 affixed to hinged 158 door assembly 100 by bracket channel 156. In a manner
35 similar to that described previously with FIG. 28, flexible gas hose 148 is used to

1 Interconnect between regulator fitting 146 (not shown) and gas line fitting 150 to secure
2 interconnection between the fuel supply (not shown) and the burner assembly.

3 FIG. 30 illustrates yet a further alternative embodiment for the positioning of the
4 gas regulator and illustrates an arrangement wherein fuel source 50 with regulator 119
5 affixed thereto is positionable within the housing by an inwardly-biased resilient spring
6 clip 160 for fastening engagement about a middle of the fuel source and a second U-
7 shaped bracket 162 fixedly attached to the heater housing for positioning about a neck
8 of the fuel source. In a manner similar to that described previously, flexible gas hose
9 148 is used to interconnect between regulator fitting 146 (not shown) and gas line fitting
10 150 (not shown) to secure interconnection between fuel supply 50 and the burner
11 assembly.

12 FIG. 31 illustrates still yet another alternative embodiment for the positioning of
13 the gas regulator and illustrates an arrangement wherein regulator 119 is fixedly
14 secured within arms of inner U-shaped bracket 166 which is pivotable within the arms of
15 outer U-shaped bracket 164 by rotational movement of inner bracket 166 about
16 cylindrical rod 168 through apertures positioned within each of the ends of the arms of
17 the respective U-shaped brackets. Once again in a manner similar to that described
18 previously, flexible gas hose 148 is used to interconnect between regulator fitting 146
19 (not shown) and gas line fitting 150 (not shown) to secure interconnection between fuel
20 supply 50 (not shown) and the burner assembly.

21 FIGS. 32 and 32a illustrate still yet a further alternative embodiment for the
22 positioning of the gas regulator and illustrates an arrangement wherein regulator 119 is
23 additionally equipped with rotating clip 172 with weight 174 positioned about a terminal
24 edge. When the heater is in its up-right position 170 as illustrated in FIG. 32a, clip 172
25 prohibits regulator 119 from rotating. When the heater is positioned on its back side, the
26 clip swings back into a second position 178 due to the gravitational effects upon weight
27 174 thereby swinging out of the way and allowing pivotal movement of the tank for
28 changing thereof. With the incorporation of a weighted clip, the rotating feature for tank
29 installation and removal is effected without changing the elevation of the tank as it
30 moves from a first angular position to a second angular position.

31 Therefore, what has been shown and illustrated is a portable heating device in
32 which the fuel source (typically at least one, and preferably two one pound cylinders)
33 plus associated regulator (for decreasing the pressure of the exit port gas) are moveable
34 from a first use position into a second position in which the fuel source is replaced. This
35 mode of operation in one embodiment is effected through the incorporation of a braided

1 ~~gas~~ ~~fuel~~ ~~which~~ ~~employs~~ ~~a~~ ~~sliding~~ mechanism in which the user physically pulls the
2 cylinder from its use position inside the housing, to a replace position outside of the
3 housing via telescoping or sliding movement of rails. In a second embodiment, this
4 mode of operation is effected by the fixed incorporation of the regulator into a door in the
5 housing within which is positioned the fuel source, thereby requiring the user to open the
6 door with cylinder attached for replacement of the cylinder. In a third embodiment, this
7 mode of operation is effected by removal of the fuel source from within the housing
8 which is attached by a clamp and bracket within the housing while in a fourth
9 embodiment, this mode of operation is effected by pivotal movement of a fixed regulator
10 within a pair of U-shaped clamps having a pivot rod interposed therebetween. In yet a
11 fifth embodiment, this mode of operation is effected by a swivel weighted clip which
12 requires tilting of the heater prior to removal of the spent fuel cylinder.

13 In the foregoing description, certain terms have been used for brevity, clearness
14 and understanding; but no unnecessary limitations are to be implied therefrom beyond
15 the requirements of the prior art, because such terms are used for descriptive purposes
16 and are intended to be broadly construed. Moreover, the description and illustration of
17 the invention is by way of example, and the scope of the invention is not limited to the
18 exact details shown or described.

19 This invention has been described in detail with reference to specific
20 embodiments thereof, including the respective best modes for carrying out each
21 embodiment. It shall be understood that these illustrations are by way of example and
22 not by way of limitation.

What is Claimed:

1. A portable gas-fired infrared heater comprising:
 - (a) a housing enclosing a burner assembly including a gas valve adapted to receive fuel from an associated fuel supply;
 - (b) said housing at least partially enclosing at least one fuel source;
 - (c) an oxygen depletion monitoring means associated with the burner assembly for automatically shutting off the burner assembly at a predetermined content of at least one gas selected from the group consisting of oxygen, carbon dioxide and carbon monoxide;
 - (d) at least one regulator interposed between said fuel source and said gas valve; and
 - (e) at least one means by which said fuel source and said regulator are moveable between a first use position and a second position in which said fuel source is replaced.
2. The portable heater of claim 1 which further comprises
a flexible gas hose interposed between said regulator and said valve.
3. The portable heater of claim 2 wherein said at least one means is
at least one pair of rails which telescope between said first and second positions.
4. The portable heater of claim 2 wherein said at least one means is
at least one pair of rails which slide between said first and second positions.
5. The portable heater of claim 3 which further comprises
a bracket for securing said regulator at the end of said rails.
6. The portable heater of claim 4 which further comprises
a bracket for securing said regulator at the end of said rails.
7. The portable heater of claim 2 which further comprises
a bracket for securing said regulator, said bracket fixedly secured within a hinged
openable door containing said fuel source.
8. The portable heater of claim 2 which further comprises
a resilient inwardly-biased clip for positioning about the middle of said fuel source
at least partially contained within said housing; and
a U-shaped bracket for positioning about the neck of said fuel source.

9. The portable heater of claim 2 which further comprises
- an outer U-shaped bracket having a pair of arms attached to said frame and having at least one aperture at an end of each arm;
 - an inner U-shaped bracket having a pair of arms attached to said frame and having at least one aperture at an end of each arm; and
 - a cylindrical rod which penetrates through all said apertures in said brackets to permit hinged swinging movement of said regulator which is fixedly secured within said inner bracket.
10. The portable heater of claim 2 wherein said at least one means is
- a swivelable regulator with a rotatable weighted clip affixed thereto, said weighted clip movable from a first position which prohibit angular rotation of said regulator when said heater is in an upright position to a second position which allows angular rotation of said regulator when said heater is positioned on its back by rotation of said weighted clip into said second position.
11. The portable heater of claim 1 wherein said at least one means is
- a swivelable regulator rotatable between a pair of arms of a U-shaped bracket fixedly secured to said housing of said heater,
 - said regulator having a gas exit port secured to one end of said bracket,
 - said regulator rotatable on said exit port side by sliding contact engagement with at least one O-ring positioned within a first annular groove about a circumference of said exit port.
12. The portable heater of claim 11 wherein said gas exit port further comprises
- at least one second annular groove about a circumference of said exit port for a retaining screw.
13. The portable heater of claim 1 wherein
- said at least one fuel source is at least two one pound propane fuel tanks.
14. The portable heater of claim 13 wherein
- said at least one fuel source is completely enclosed within said housing.
15. The portable heater of claim 14 wherein
- said at least two one pound propane fuel tanks are completely enclosed within said housing.

16. The portable heater of claim 15 which further comprises
 - a controller for selectively switching operation of the portable heater among at least discrete off, pilot, low, and high positions.
17. The portable heater of claim 1 which further comprises
 - a controller for continuous variable operation of the portable heater.
18. The portable heater of claim 1 wherein
 - the regulator limits the pressure of an associated fuel source to approximately eleven inches water column.
19. The portable heater of claim 1 which further comprises
 - a thermocouple that monitors changes in temperature of a pilot flame associated with the radiant surface.
20. The portable heater of claim 1 which further comprises
 - a shield secured to the housing in overlapping relation to the radiant surface.
21. The portable heater of claim 1 which further comprises
 - at least one fan to increase air circulation through said heater; and
 - a power source for said at least one fan.
22. The portable heater of claim 21 wherein
 - said power source is selected from the group consisting of at least one dry cell battery, at least one battery pack and a power cord configured to plug into a source of electricity.
23. The portable heater of claim 22 wherein
 - said power source is rechargeable.
24. The portable heater of claim 1 which further comprises
 - an access means to said at least one fuel source.
25. The portable heater of claim 24 wherein
 - said access means is a door in said housing.
26. The portable heater of claim 13 wherein
 - said at least two fuel sources are positioned on one side of said heater.
27. The portable heater of claim 13 wherein
 - said at least two fuel sources are positioned on a rear side of said heater.
28. The portable heater of claim 13 wherein
 - said at least two fuel sources are positioned on opposed sides of said heater.
29. The portable heater of claim 13 which further comprises

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an igniter for each fuel source.

30. The portable heater of claim 29 which further comprises
a controller for each fuel source.
31. A portable radiant heater comprising:
 - (a) a housing;
 - (b) an air inlet in the housing;
 - (c) a burner assembly mounted in the housing including at least one fuel valve adapted to operatively communicate with at least one associated fuel source and the air inlet; and
 - (d) a radiant surface having a rear face communicating with a plenum chamber and wherein the radiant surface is recessed in the housing; and
 - (e) an oxygen depletion system operatively associated with the burner assembly for automatically shutting off the fuel valve in response to detection of a predetermined level of at least one gas selected from the group consisting of oxygen, carbon dioxide and carbon monoxide.
32. The portable heater of claim 31 which further comprises
at least two fuel valves; and
at least two fuel sources.
33. The portable heater of claim 32 wherein
said radiant surface is angled; and
said plenum chamber is adjacent to the radiant surface for distributing an associated air/fuel mixture over the rear face of the radiant surface.
34. The portable heater of claim 33 wherein
said regulator limits the pressure of the associated fuel source to approximately eleven inches water column.
35. The portable heater of claim 34 which further comprises
a handle; and
a control knob for selecting various modes of operation of the heater, the control knob located in a recess of the housing for limiting inadvertent contact.
36. The portable heater of claim 35 wherein
the heater includes a controller for providing at least 4000 BTUs/hour in a first operative state and at least 9000 BTUs/hour in a second operative state.
37. The portable heater of claim 35 which further comprises

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an elongated hose assembly for interconnecting the heater to an associated

remotely located fuel source.

38. The portable heater of claim 31 wherein
the housing includes at least one cavity dimensioned for receiving at least one
associated fuel source therein.
39. The portable heater of claim 31 which further comprises
a venturi interposed between the at least one fuel valve and the radiant surface for
mixing the associated fuel with air.
40. The portable heater of claim 31 wherein
said at least one fuel source is a one pound propane cylinder.
41. The portable heater of claim 40 wherein
said at least one fuel source is at least two one pound propane cylinders.
42. The portable heater of claim 31 which further comprises
a thermocouple that monitors changes in temperature of a pilot flame associated
with the radiant surface.
43. The portable heater of claim 31 which further comprises
a shield secured to the housing in overlapping relation to the radiant surface.
44. The portable heater of claim 31 which further comprises
at least one fan to increase air circulation through said heater; and
a power source for said at least one fan.
45. The portable heater of claim 44 wherein
said power source is selected from the group consisting of at least one dry cell
battery, at least one battery pack and a power cord configured to plug into a
source of electricity.
46. The portable heater of claim 45 wherein
said power source is rechargeable.
47. The portable heater of claim 31 which further comprises
an access means to said at least one fuel source.
48. The portable heater of claim 47 wherein
said access means is a door in said housing.
49. The portable heater of claim 31 which further comprises
at least one pivotable fitting for connection to said at least one fuel source.
50. The portable heater of claim 41 wherein

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said at least two fuel sources are positioned on one side of said heater.

51. The portable heater of claim 41 wherein
said at least two fuel sources are positioned on a rear side of said heater.
52. The portable heater of claim 41 wherein
said at least two fuel sources are positioned on opposed sides of said heater.
53. The portable heater of claim 41 which further comprises
an igniter for each fuel source.
54. The portable heater of claim 53 which further comprises
a controller for each fuel source.
55. A portable radiant heater comprising:
 - (a) a housing for enclosing said heater and at least partially enclosing at least a one pound fuel source;
 - (b) an air inlet in the housing;
 - (c) a burner assembly mounted in the housing including a fuel valve adapted to operatively communicate with said at least one fuel source and the air inlet;
 - (d) a radiant surface having a rear face communicating with a plenum chamber and wherein the radiant surface is recessed in the housing and disposed at an angle; and
 - (e) an automatic shutoff mechanism operatively associated with the burner assembly for shutting off the fuel valve in response to a detection of a predetermined level of at least one gas selected from the group consisting of oxygen, carbon dioxide and carbon monoxide.
56. The portable radiant heater of claim 55 wherein
the automatic shutoff mechanism includes a thermocouple that monitors changes in a temperature of a flame of the burner assembly indicative of changes in the concentration of a gas selected from the group consisting of oxygen, carbon dioxide and carbon monoxide.
57. The portable radiant heater of claim 56 wherein
the automatic shutoff mechanism shuts off at approximately 100 ppm of carbon monoxide at approximately 18% oxygen levels.
58. The portable heater of claim 55 which further comprises
an igniter secured to the housing for initiating combustion at the radiant surface.
59. The portable heater of claim 55 wherein

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the housing is dimensioned to enclose at least an upper portion of said at least one fuel source.

60. The portable heater of claim 59 wherein
said at least one fuel source is at least a one pound propane fuel tank.
61. The portable heater of claim 59 wherein
said at least one fuel source is at least two one pound propane fuel tanks.
62. The portable heater of claim 60 wherein
said at least one fuel source is completely enclosed within said housing.
63. The portable heater of claim 61 wherein
said at least two one pound propane fuel tanks are completely enclosed within said housing.
64. The portable heater of claim 55 which further comprises
a controller for selectively switching operation of the portable heater among at least discrete off, pilot, low, and high positions.
65. The portable heater of claim 55 which further comprises
a controller for continuous variable operation of the portable heater.
66. The portable heater of claim 64 wherein
the controller includes a control knob disposed in a housing recess for protecting against inadvertent contact.
67. The portable heater of claim 55 which further comprises
an extended length hose assembly for connecting the heater to an associated remote fuel source.
68. The portable heater of claim 55 which further comprises
a regulator for reducing pressure from an associated fuel source.
69. The portable heater of claim 68 wherein
the regulator limits the pressure of an associated fuel source to approximately eleven inches water column.
70. The portable heater of claim 55 which further comprises
a thermocouple that monitors changes in temperature of a pilot flame associated with the radiant surface.
71. The portable heater of claim 55 which further comprises
a shield secured to the housing in overlapping relation to the radiant surface.
72. The portable heater of claim 55 which further comprises

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at least one fan to increase air circulation through said heater; and
a power source for said at least one fan.

73. The portable heater of claim 72 wherein
said power source is selected from the group consisting of at least one dry cell battery, at least one battery pack and a power cord configured to plug into a source of electricity.
74. The portable heater of claim 73 wherein
said power source is rechargeable.
75. The portable heater of claim 55 which further comprises
an access means to said at least one fuel source.
76. The portable heater of claim 75 wherein
said access means is a door in said housing.
77. The portable heater of claim 76 which further comprises
at least one pivotable fitting for connection to said at least one fuel source.
78. The portable heater of claim 61 wherein
said at least two fuel sources are positioned on one side of said heater.
79. The portable heater of claim 61 wherein
said at least two fuel sources are positioned on a rear side of said heater.
80. The portable heater of claim 61 wherein
said at least two fuel sources are positioned on opposed sides of said heater.
81. The portable heater of claim 61 which further comprises
an igniter for each fuel source.
82. The portable heater of claim 81 which further comprises
a controller for each fuel source.
83. The portable heater of claim 1 which further comprises
at least two wheels extending from a bottom of said housing.
84. The portable heater of claim 83 wherein
said at least two wheels is four wheels, each positioned at a corner of said bottom housing.
85. The portable heater of claim 1 which further comprises
at least two burner assemblies.
86. The portable heater of claim 85 wherein
said at least two burner assemblies are independently controlled.

87. The portable heater of claim 31 which further comprises
at least two wheels extending from a bottom of said housing.
88. The portable heater of claim 87 wherein
said at least two wheels is four wheels, each positioned at a corner of said bottom
housing.
89. The portable heater of claim 31 which further comprises
at least two burner assemblies.
90. The portable heater of claim 89 wherein
said at least two burner assemblies are independently controlled.
91. The portable heater of claim 55 which further comprises
at least two wheels extending from a bottom of said housing.
92. The portable heater of claim 91 wherein
said at least two wheels is four wheels, each positioned at a corner of said bottom
housing.
93. The portable heater of claim 55 which further comprises
at least two burner assemblies.
94. The portable heater of claim 93 wherein
said at least two burner assemblies are independently controlled.

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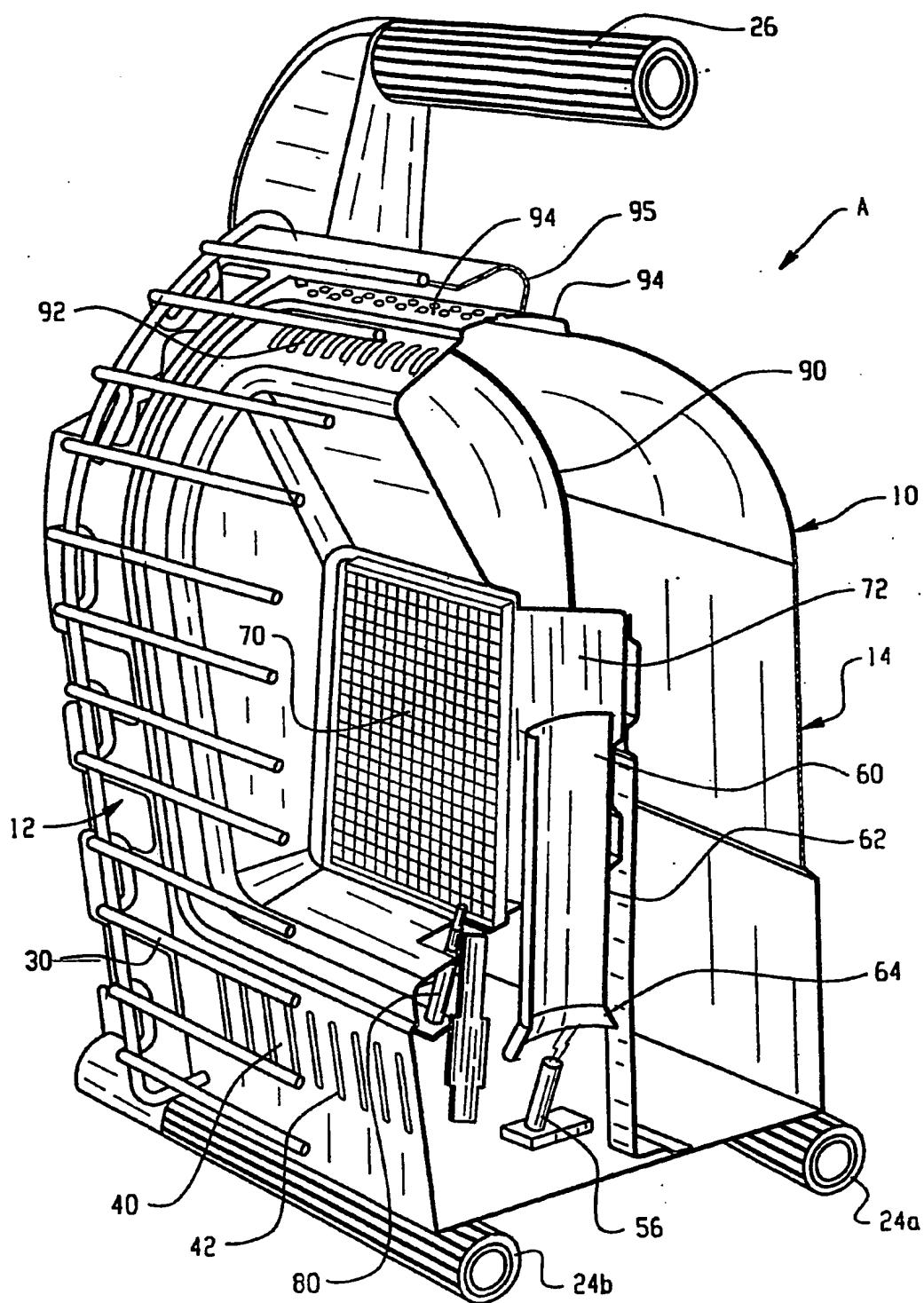


Fig. 1

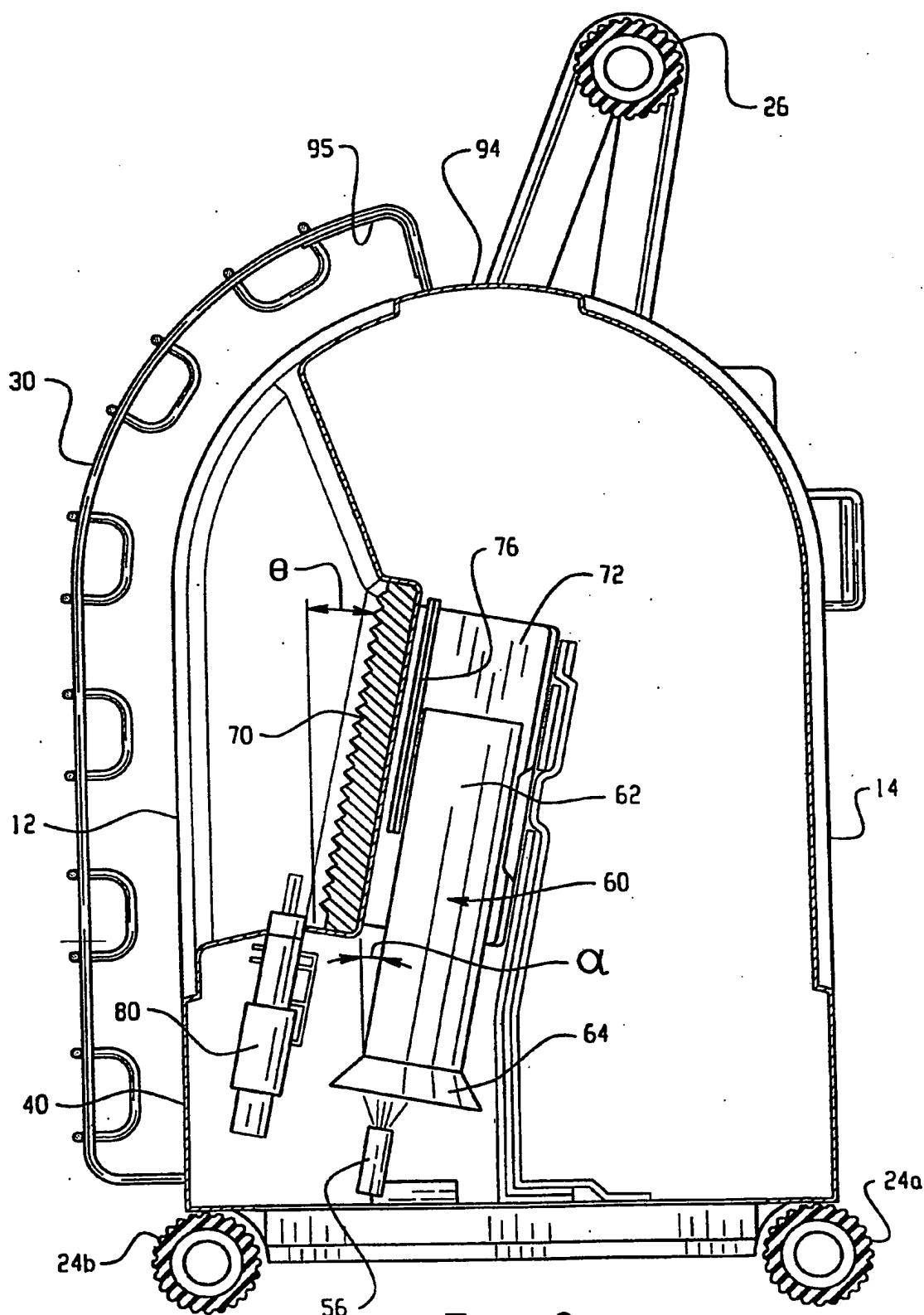


Fig. 2

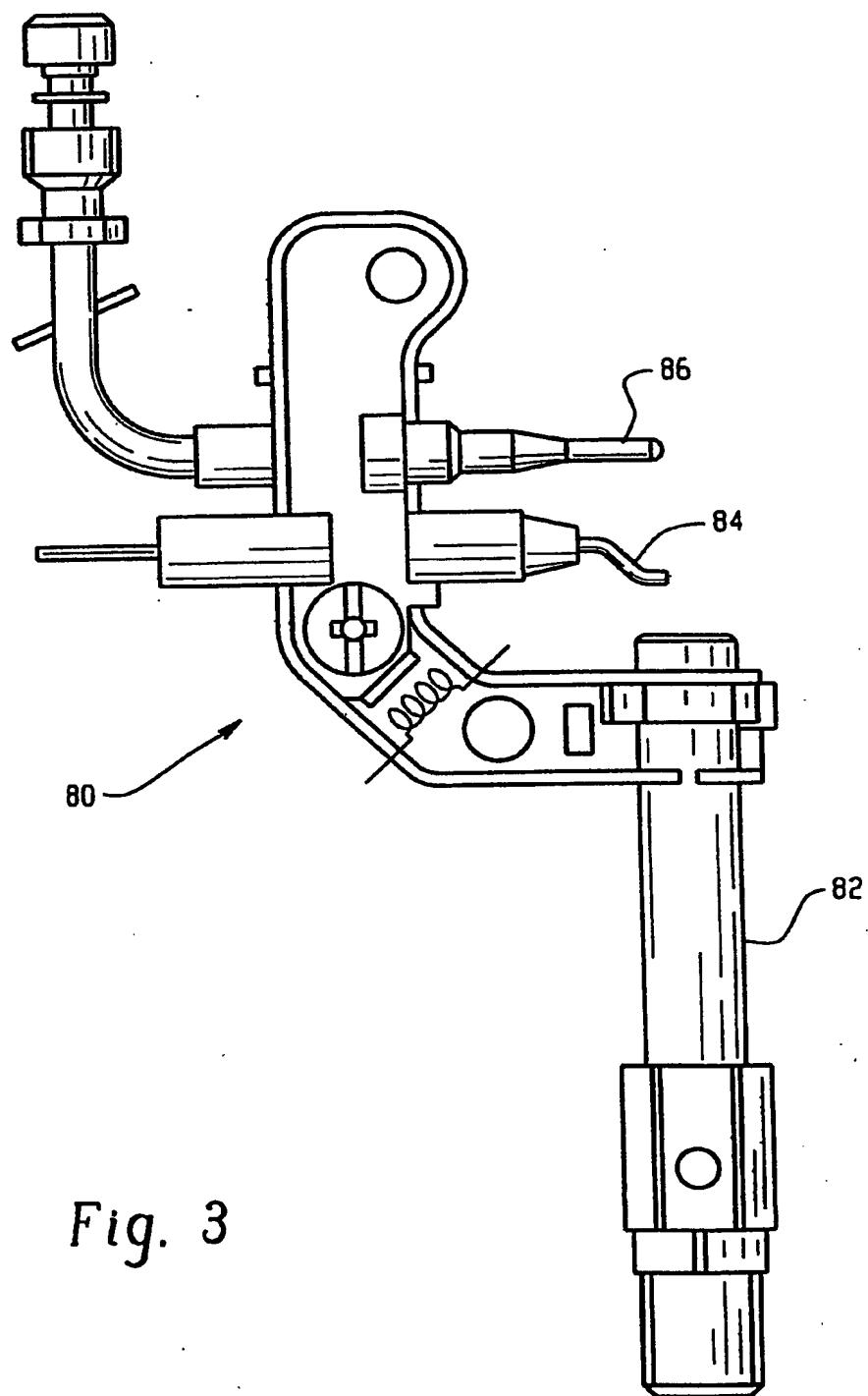


Fig. 3

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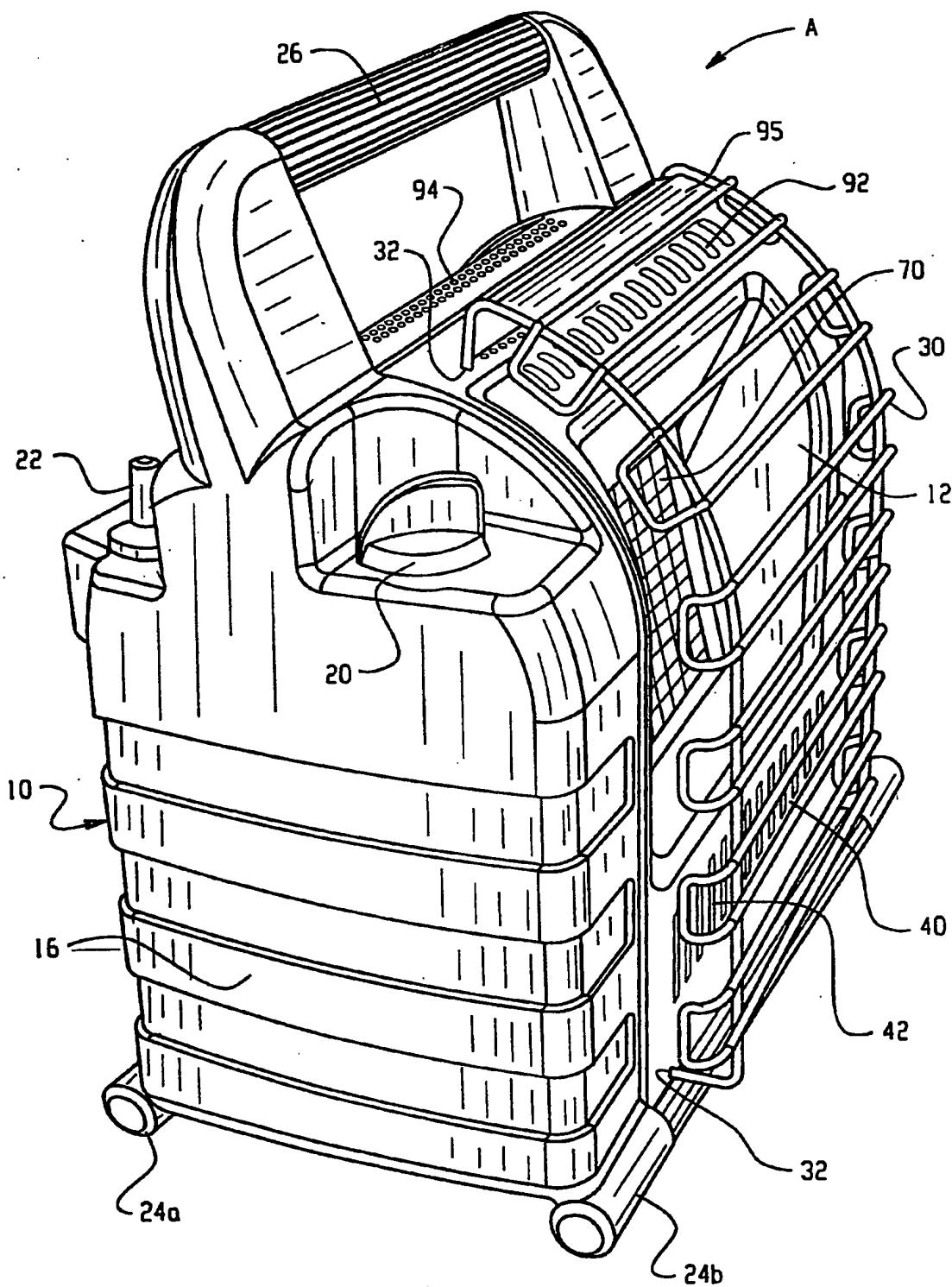


Fig. 4

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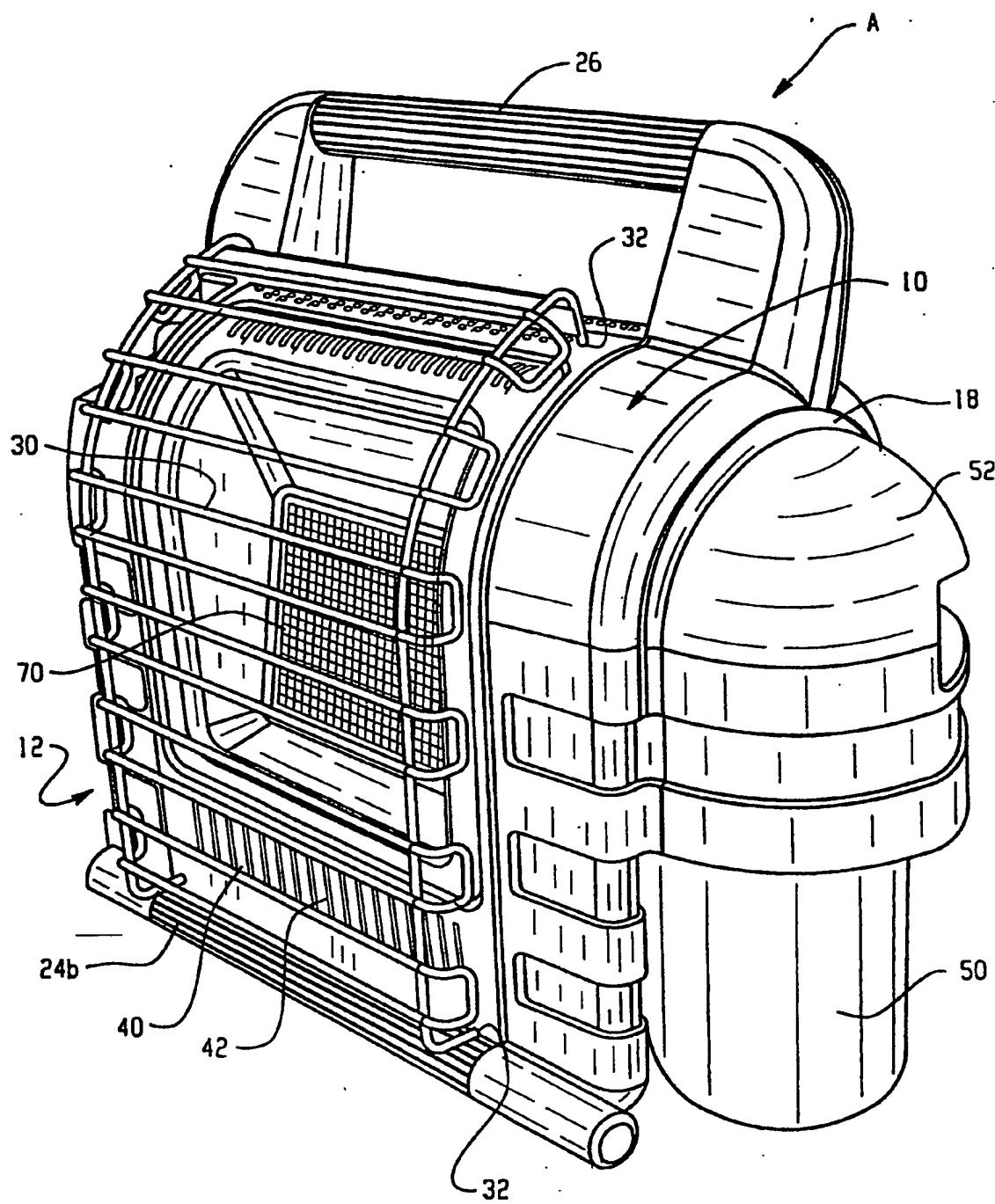


Fig. 5

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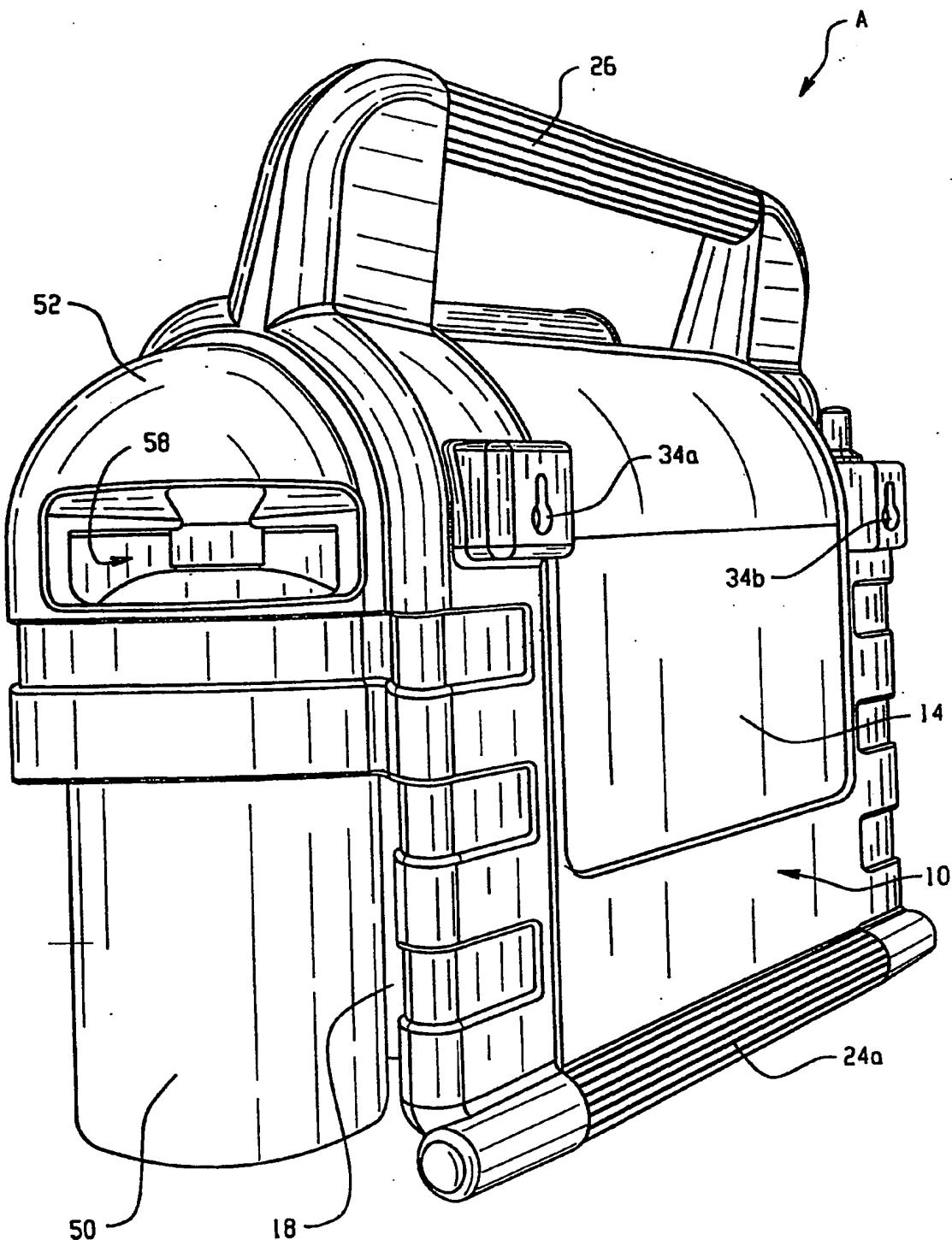


Fig. 6

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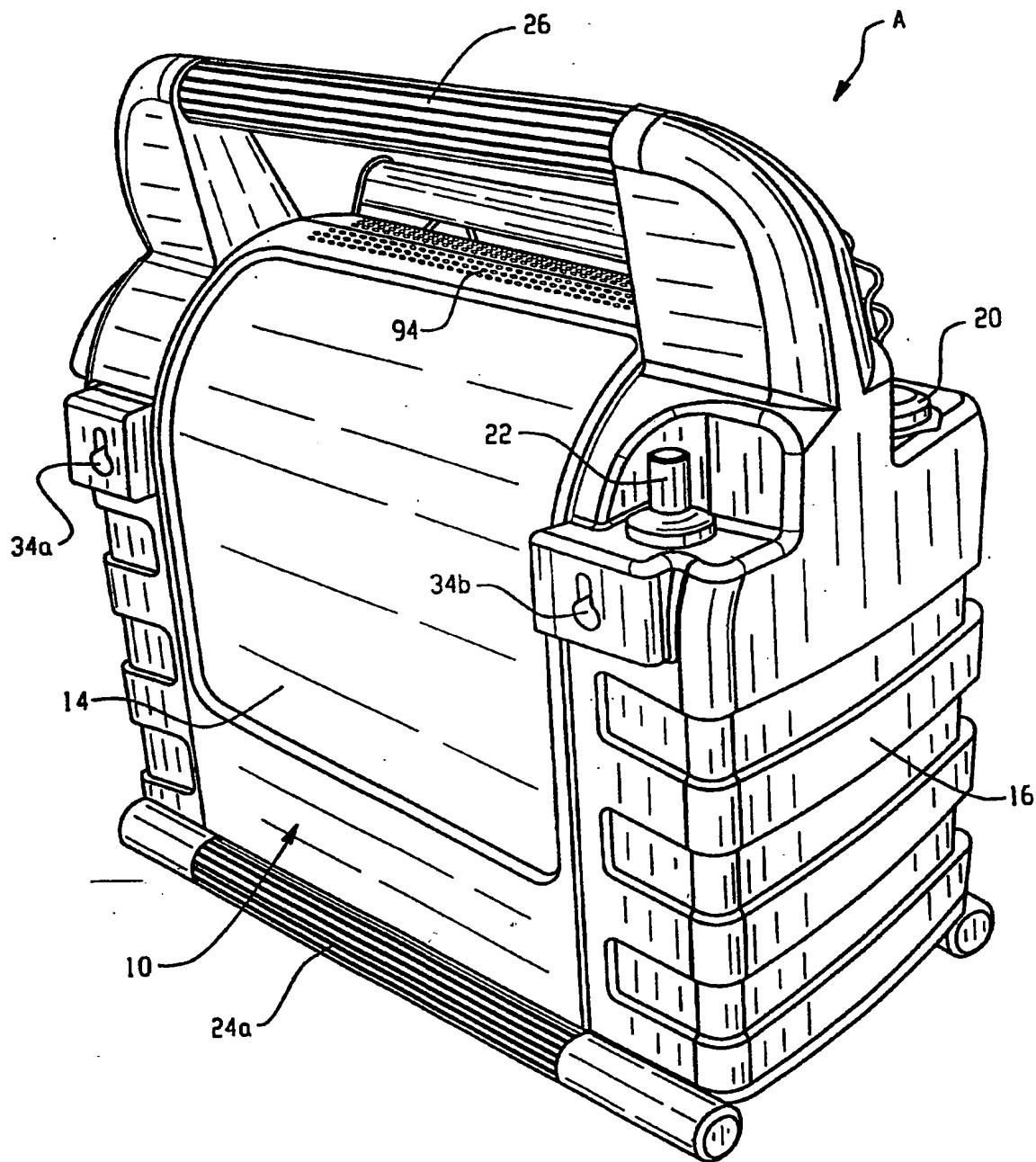


Fig. 7

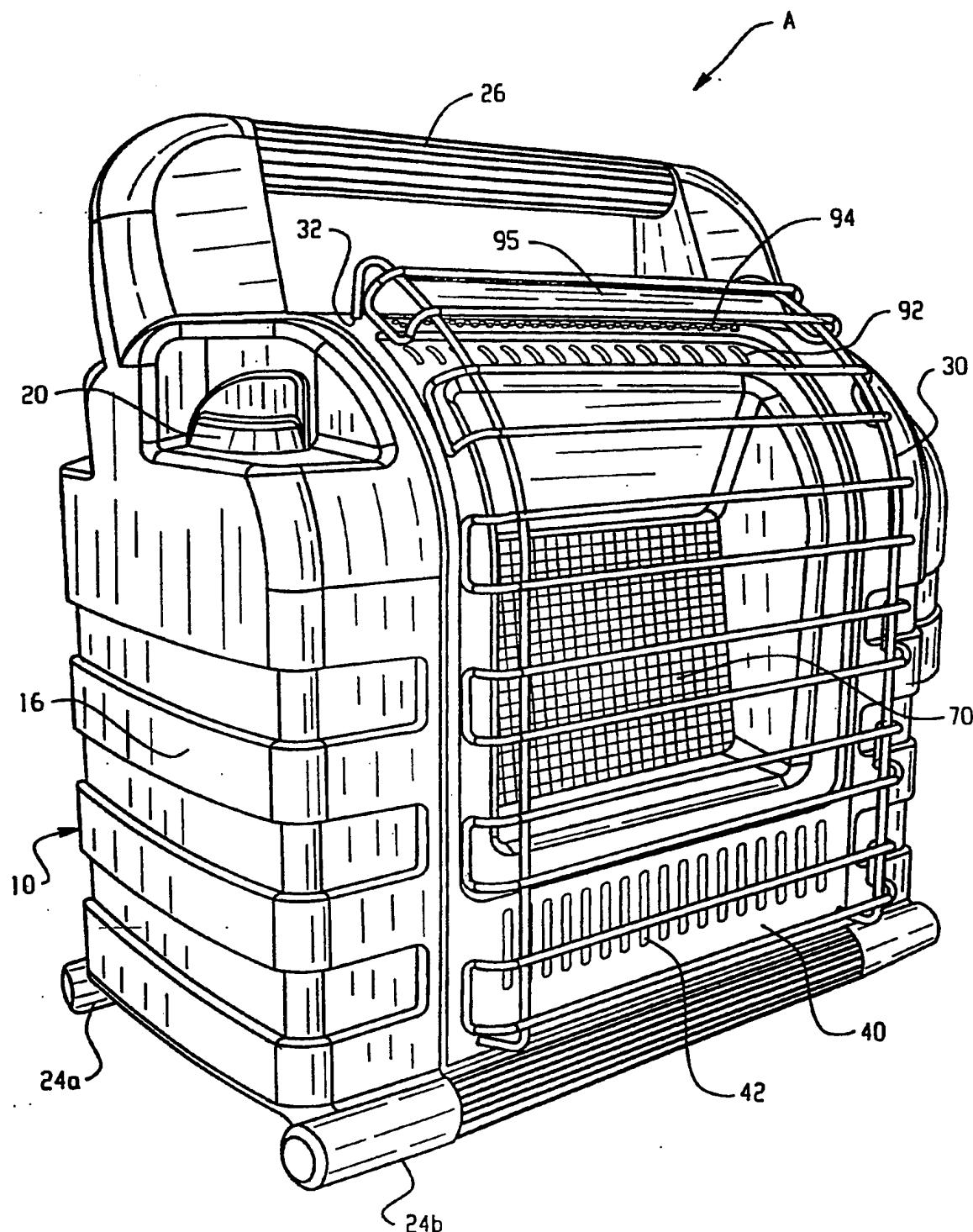


Fig. 8

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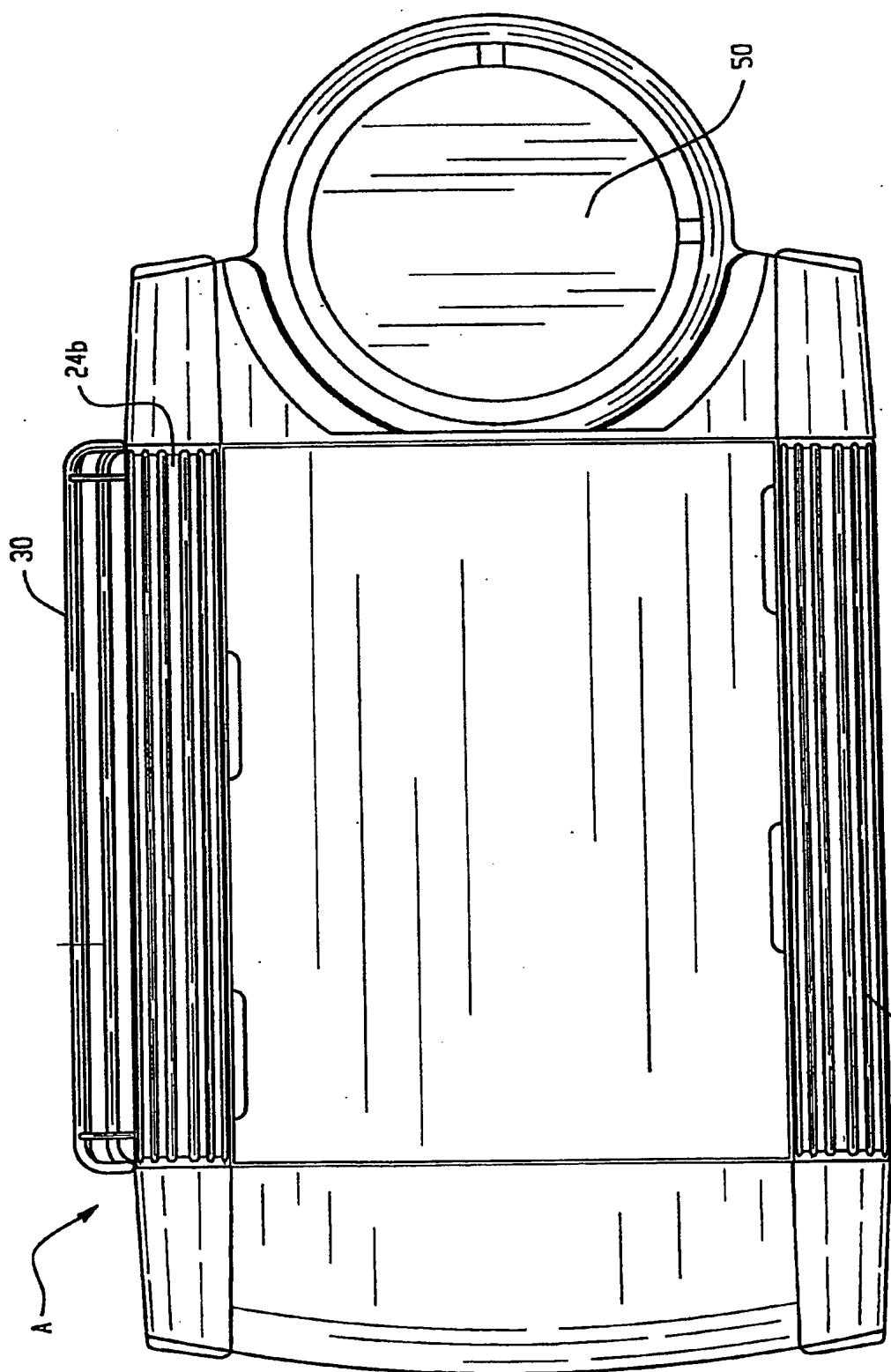


Fig. 9

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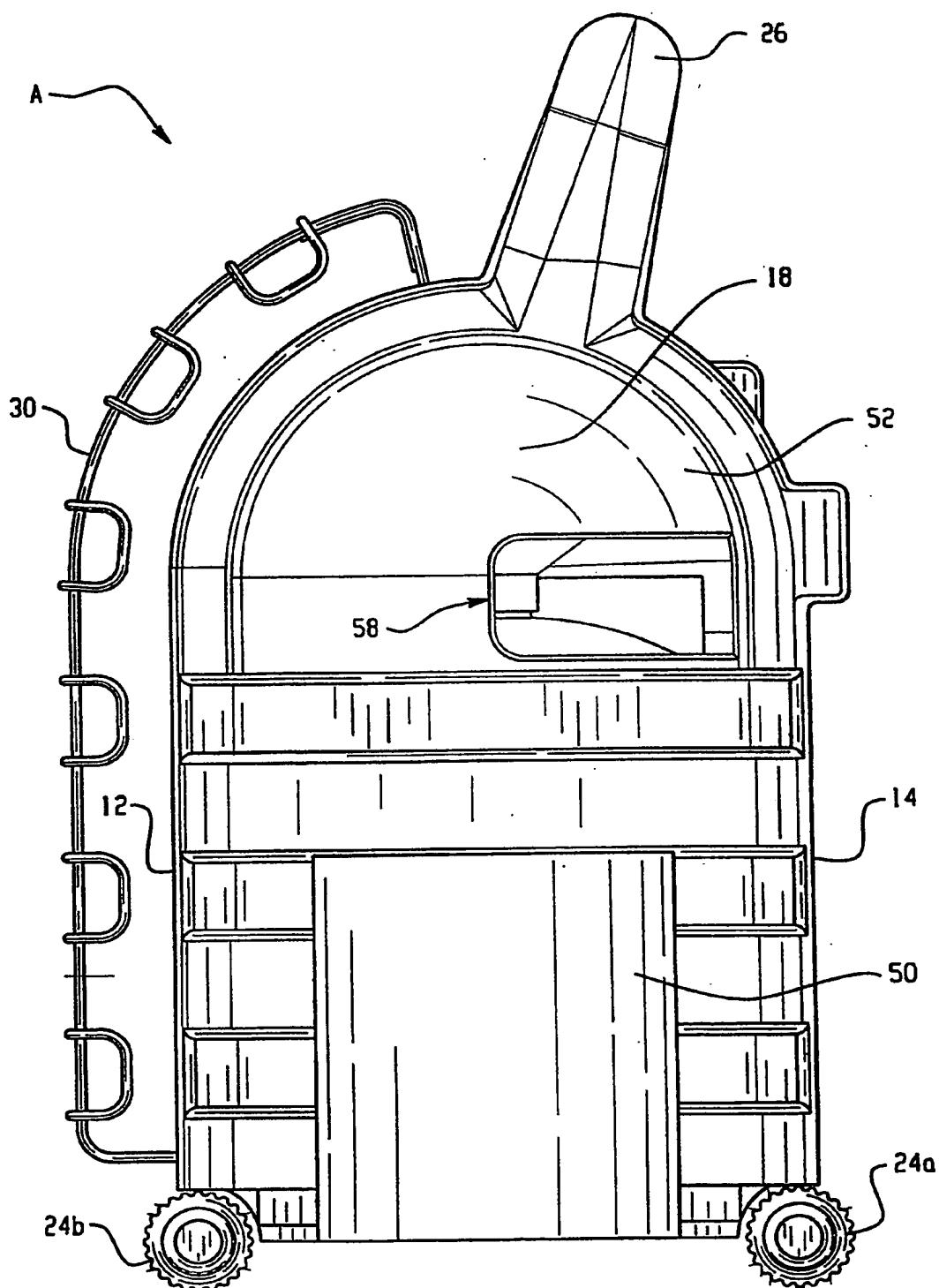


Fig. 10

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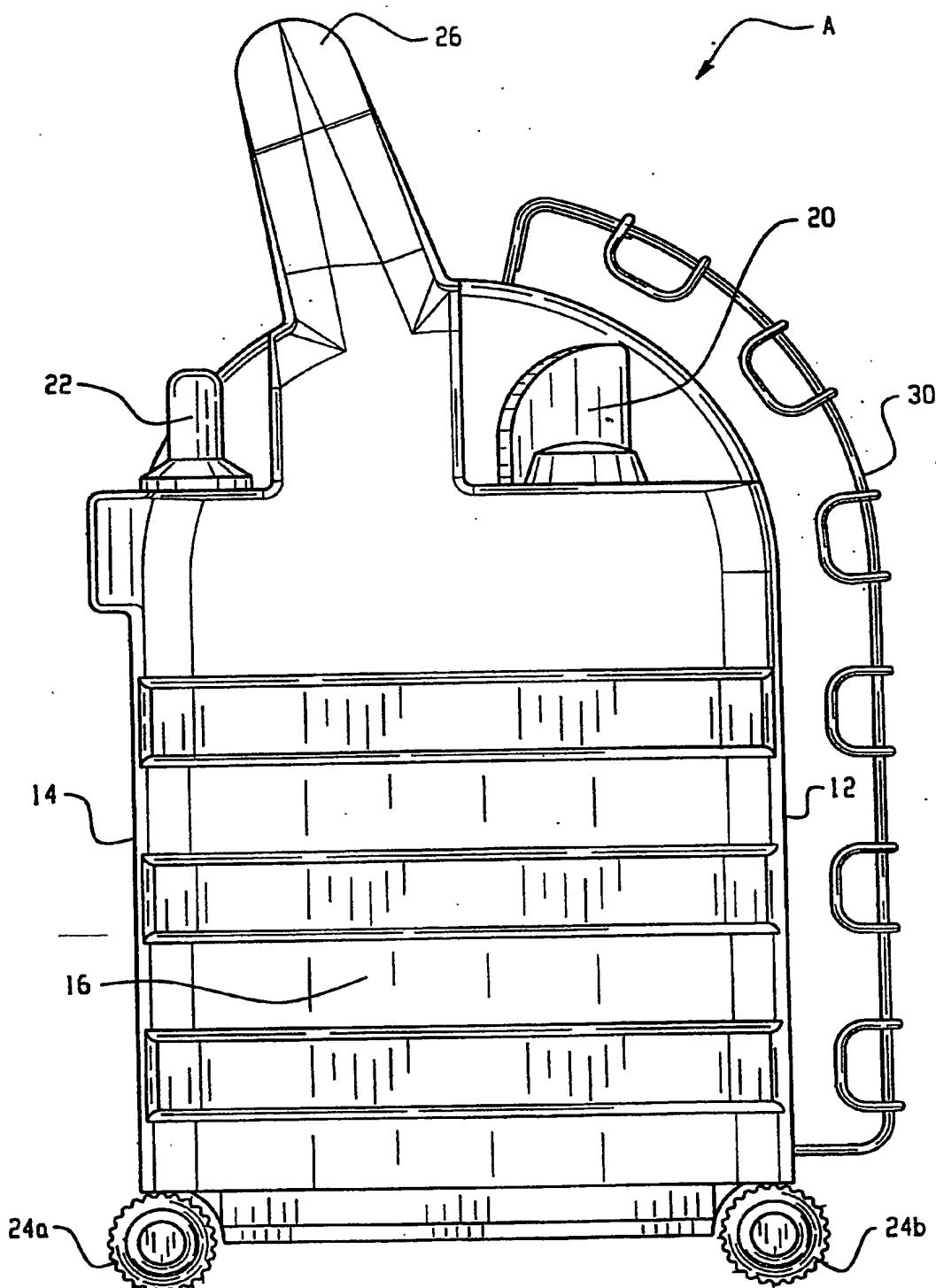


Fig. 11

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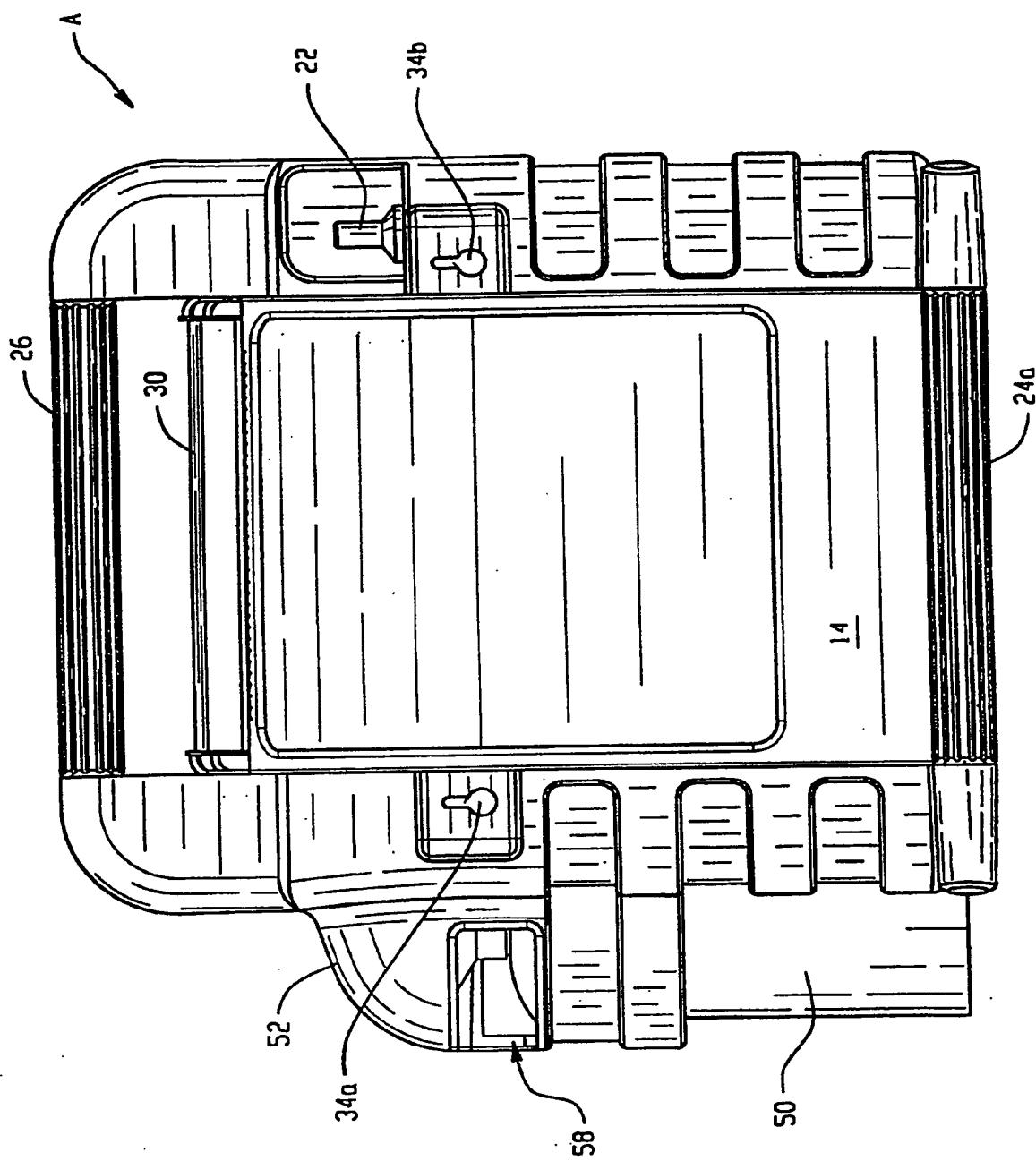


Fig. 12

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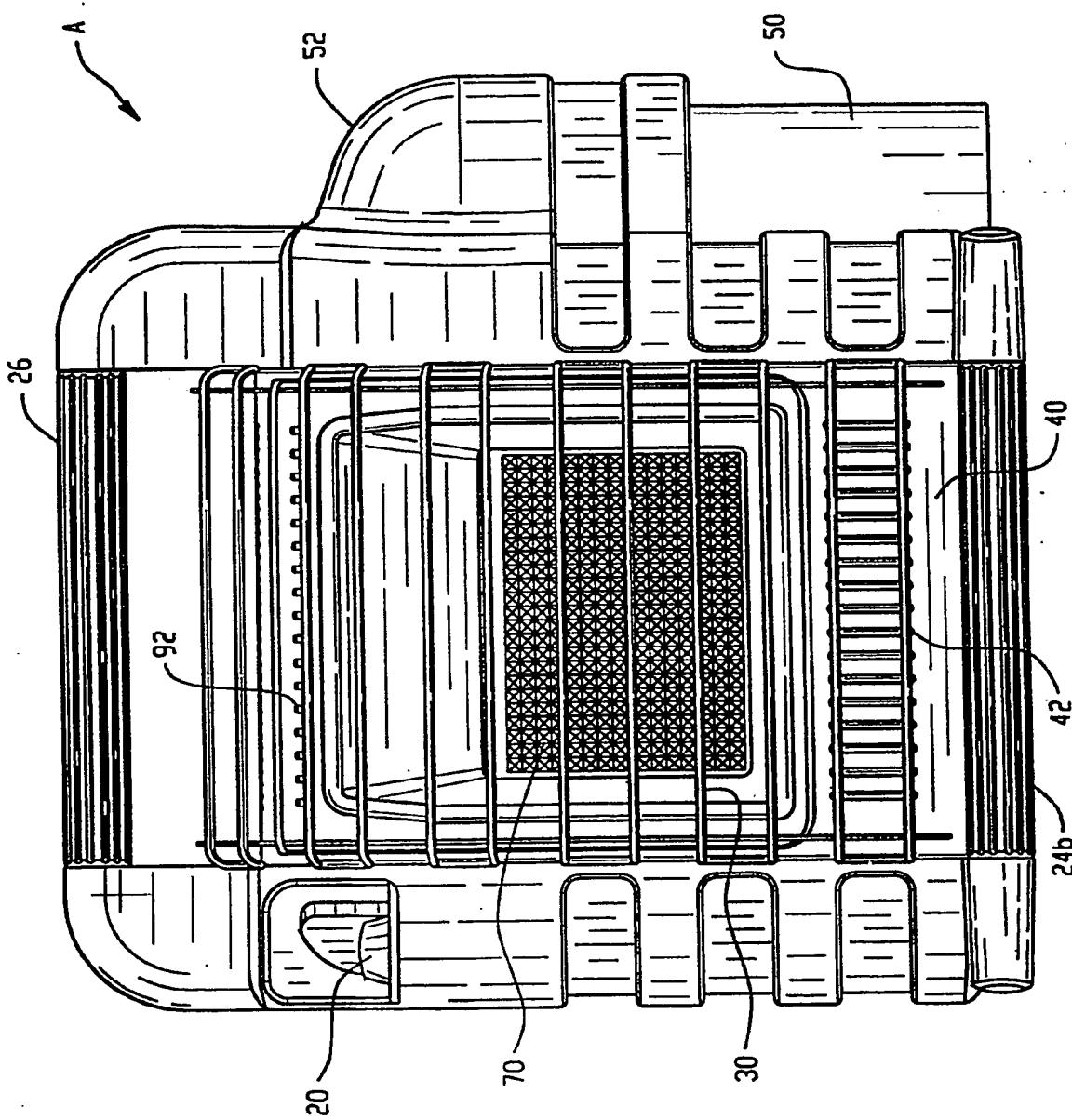
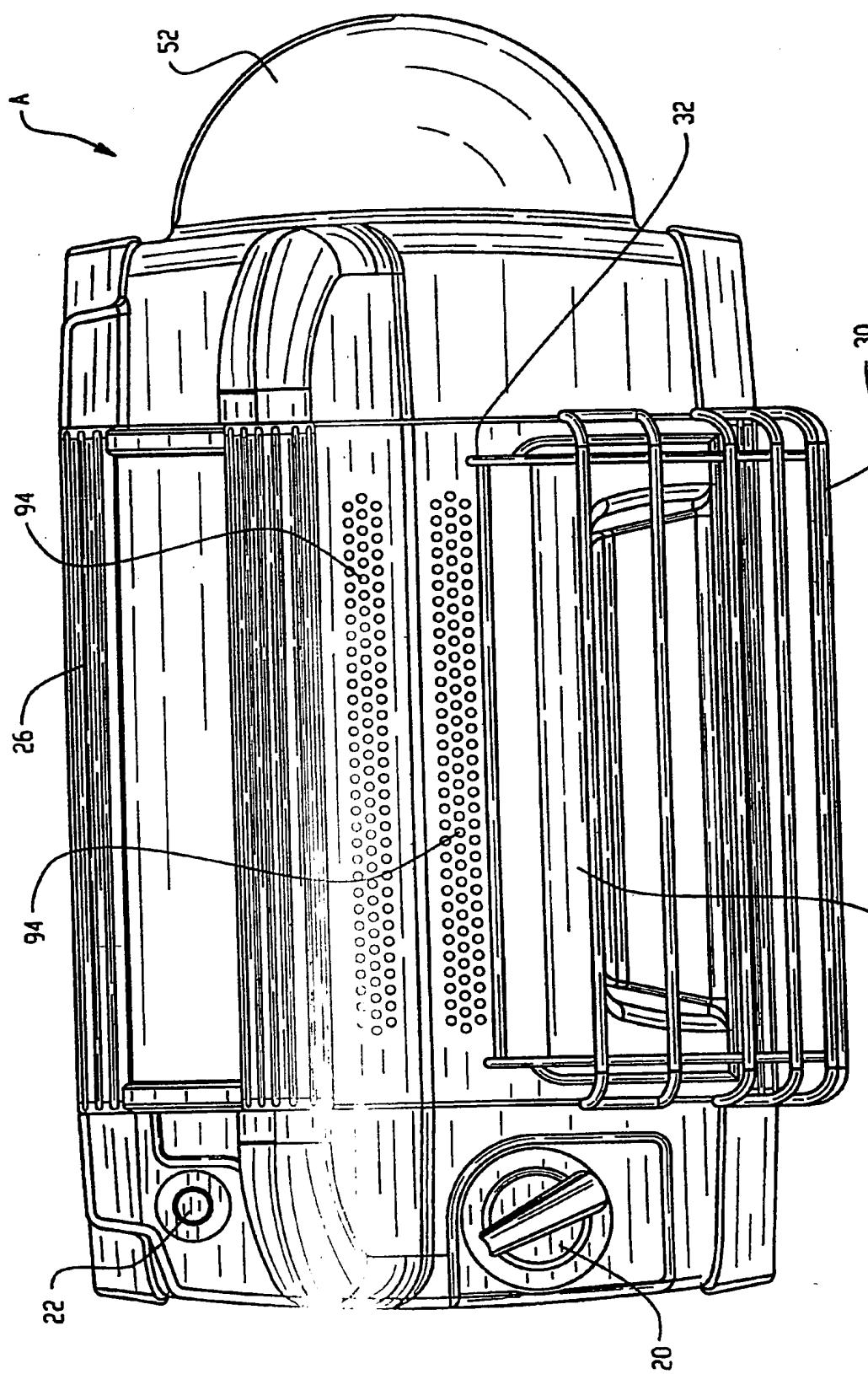


Fig. 13



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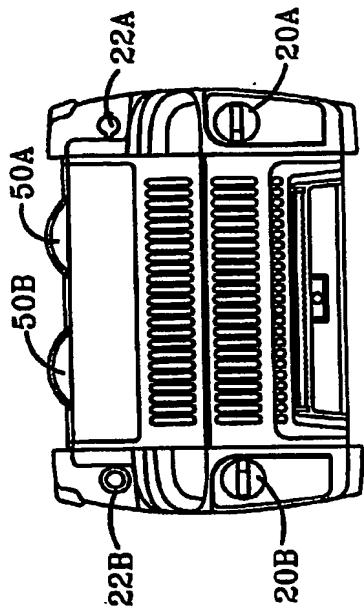


FIG-24

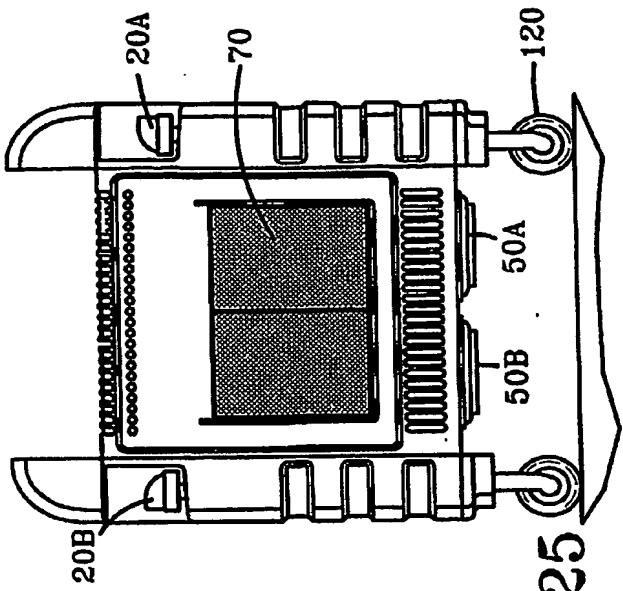


FIG-25

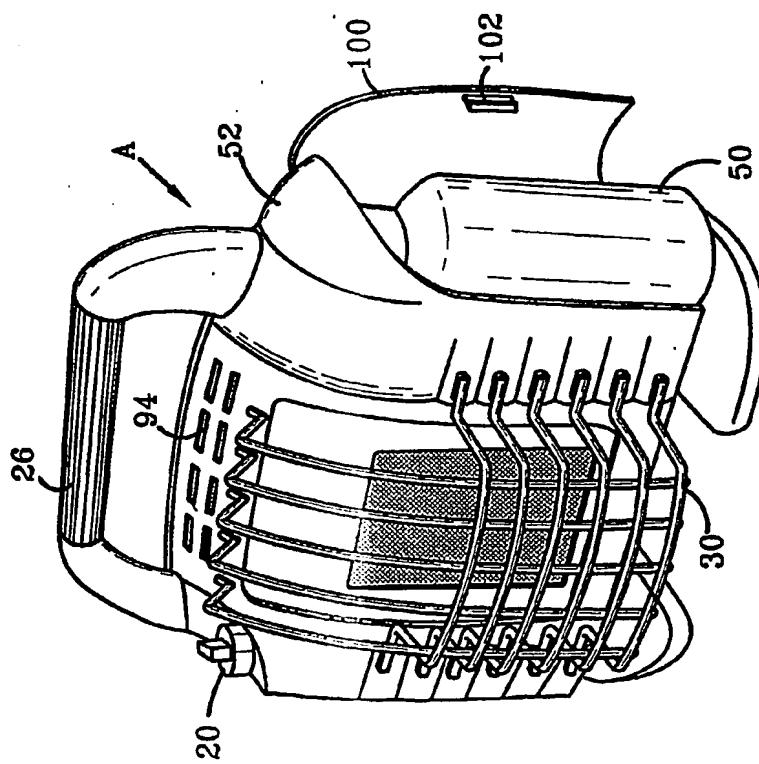


FIG-15

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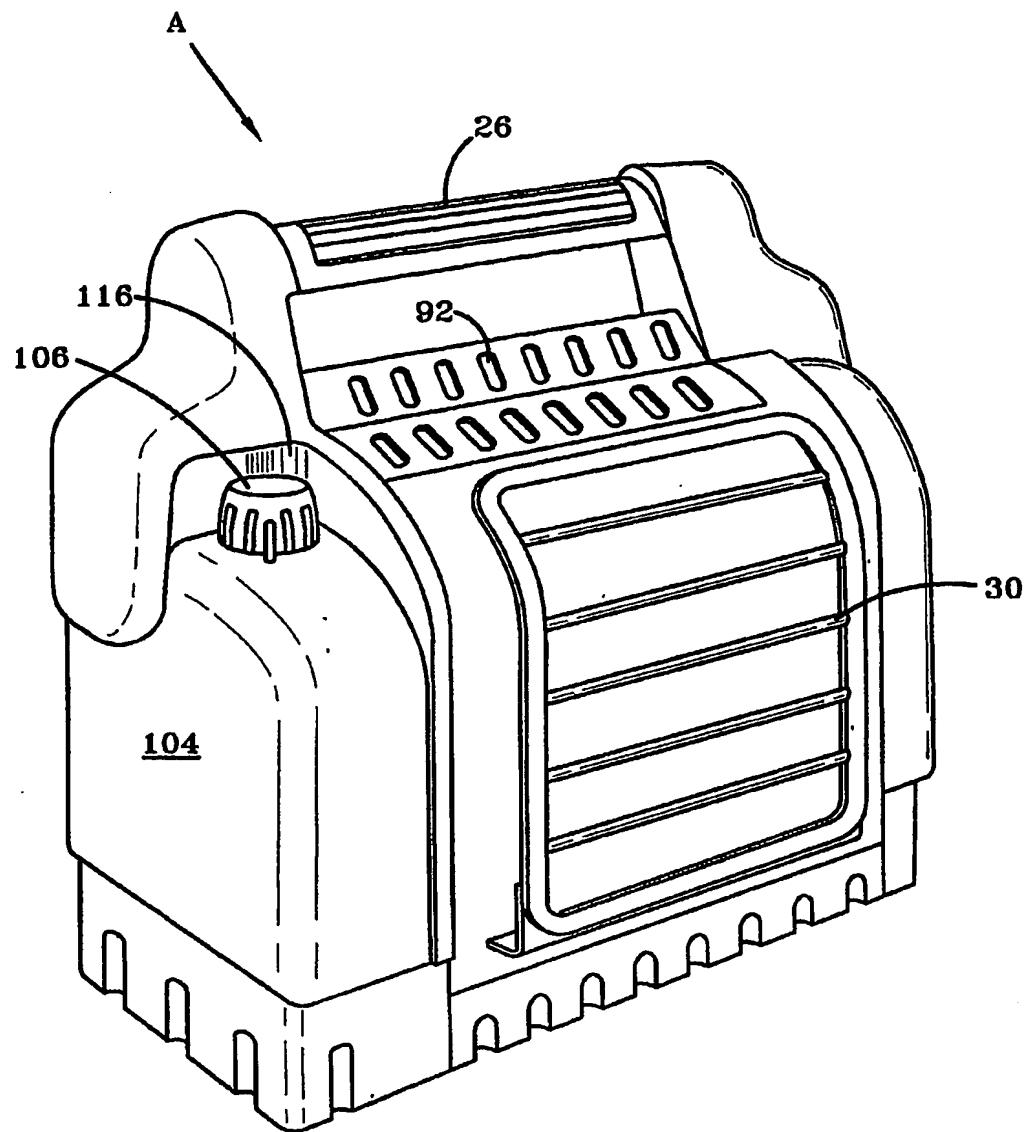
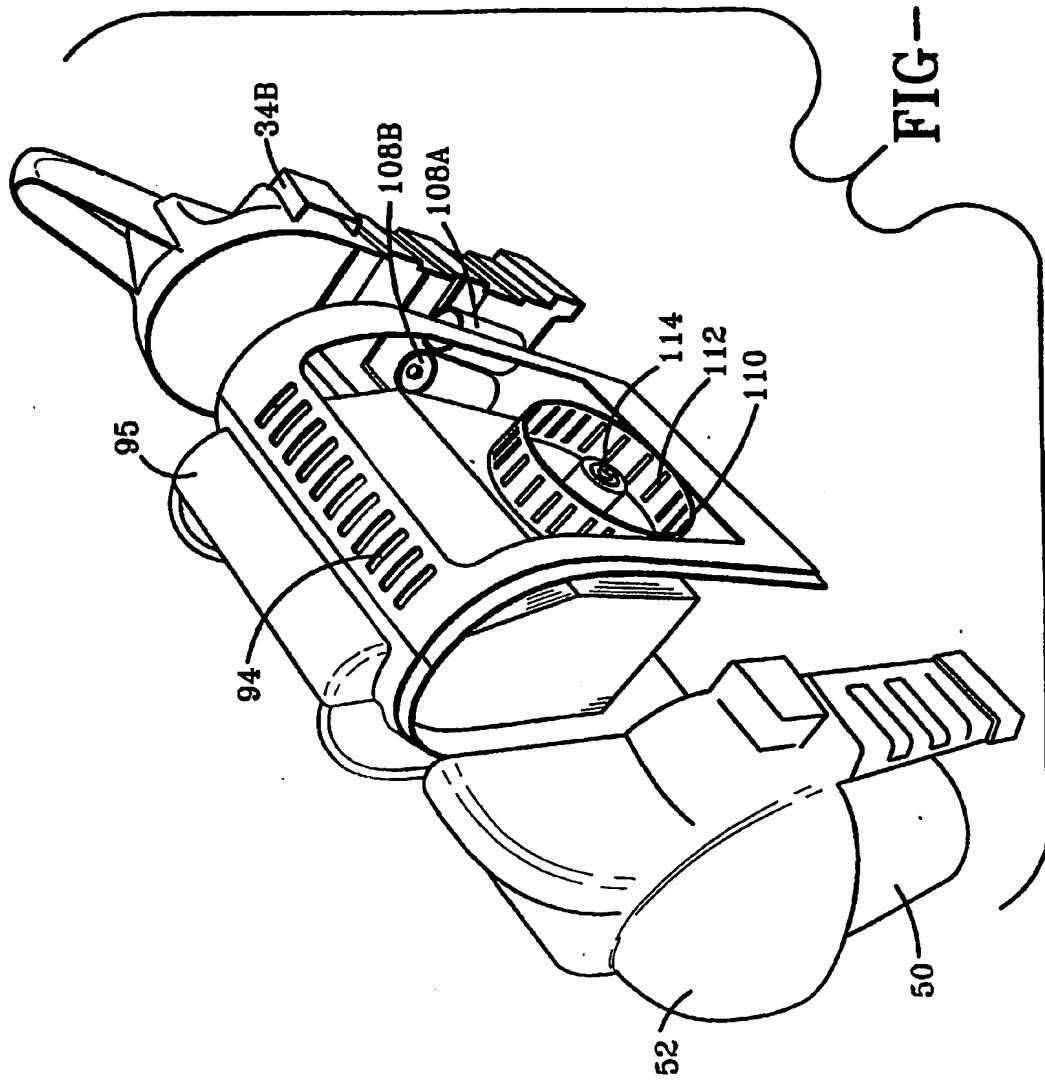


FIG-16

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FIG-17



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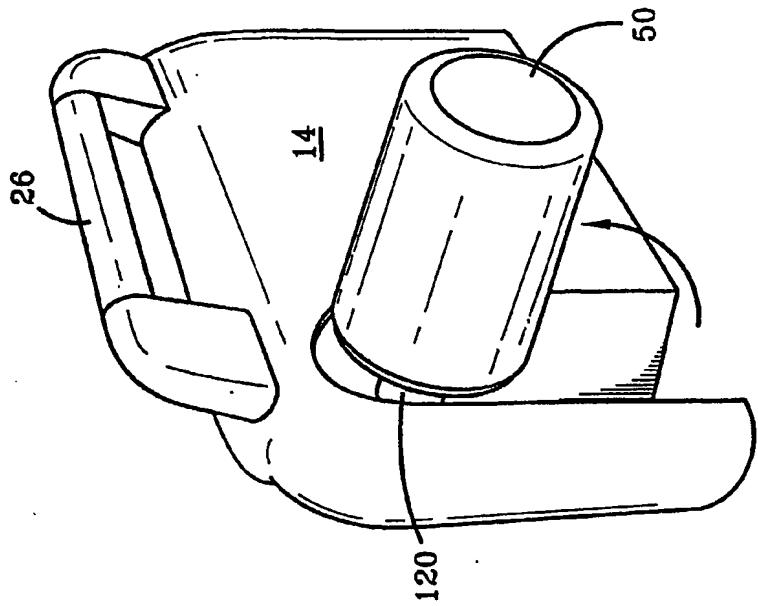


FIG-19

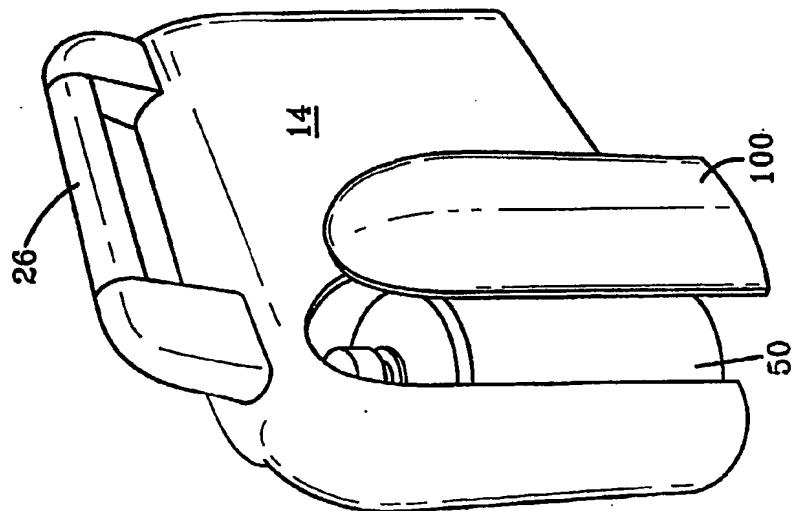


FIG-18

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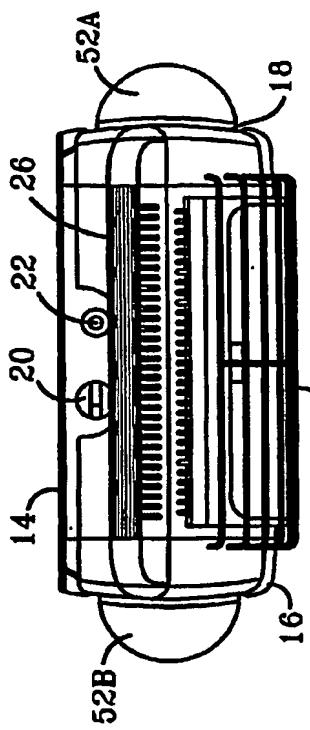


FIG-22

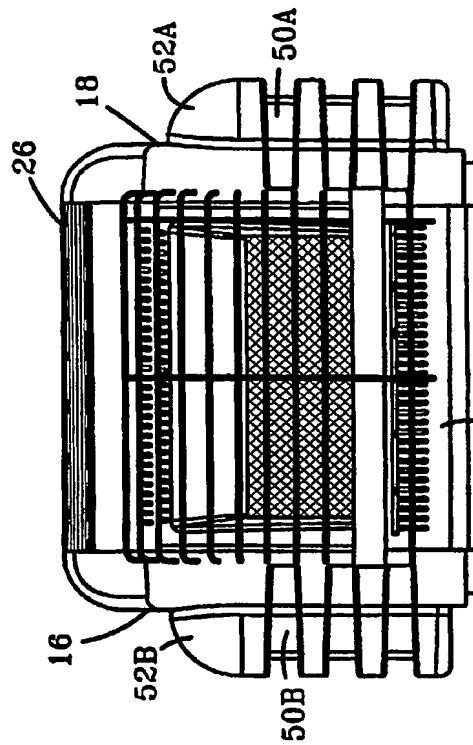


FIG-23

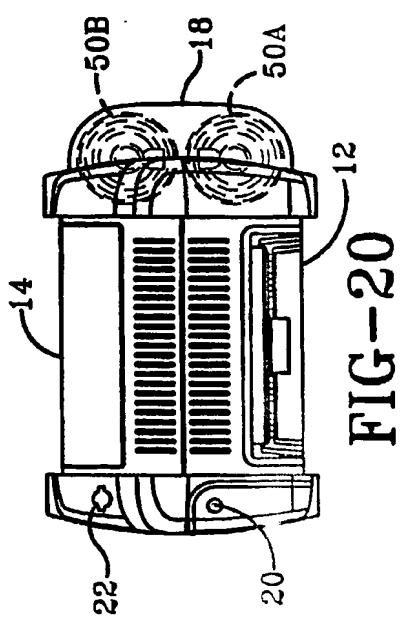


FIG-20

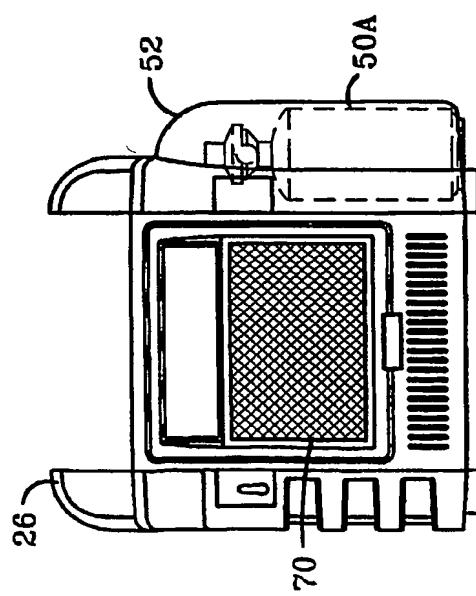


FIG-21

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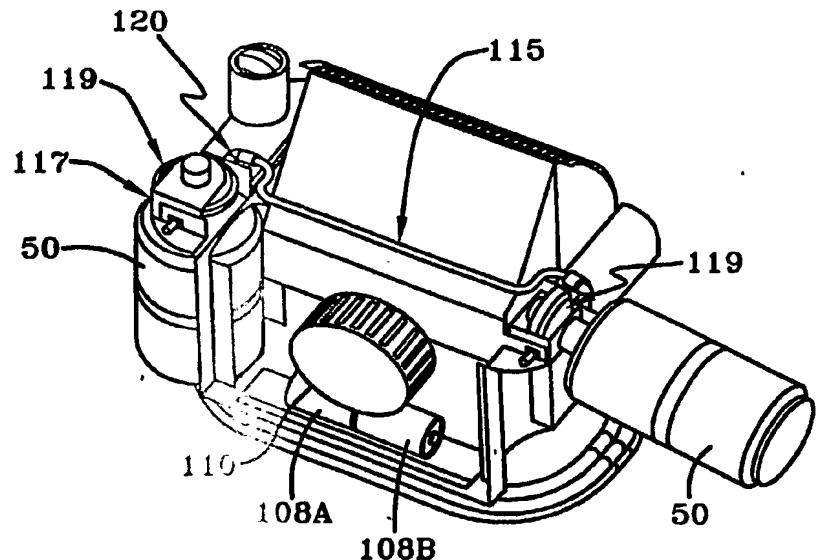


FIG-26

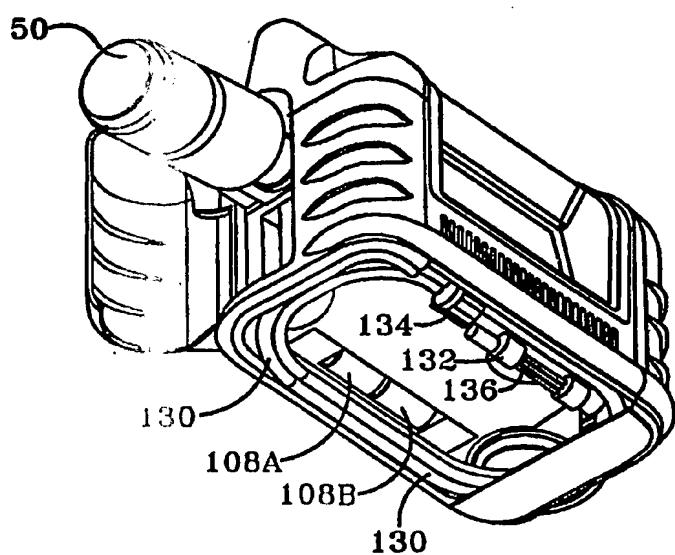


FIG-27

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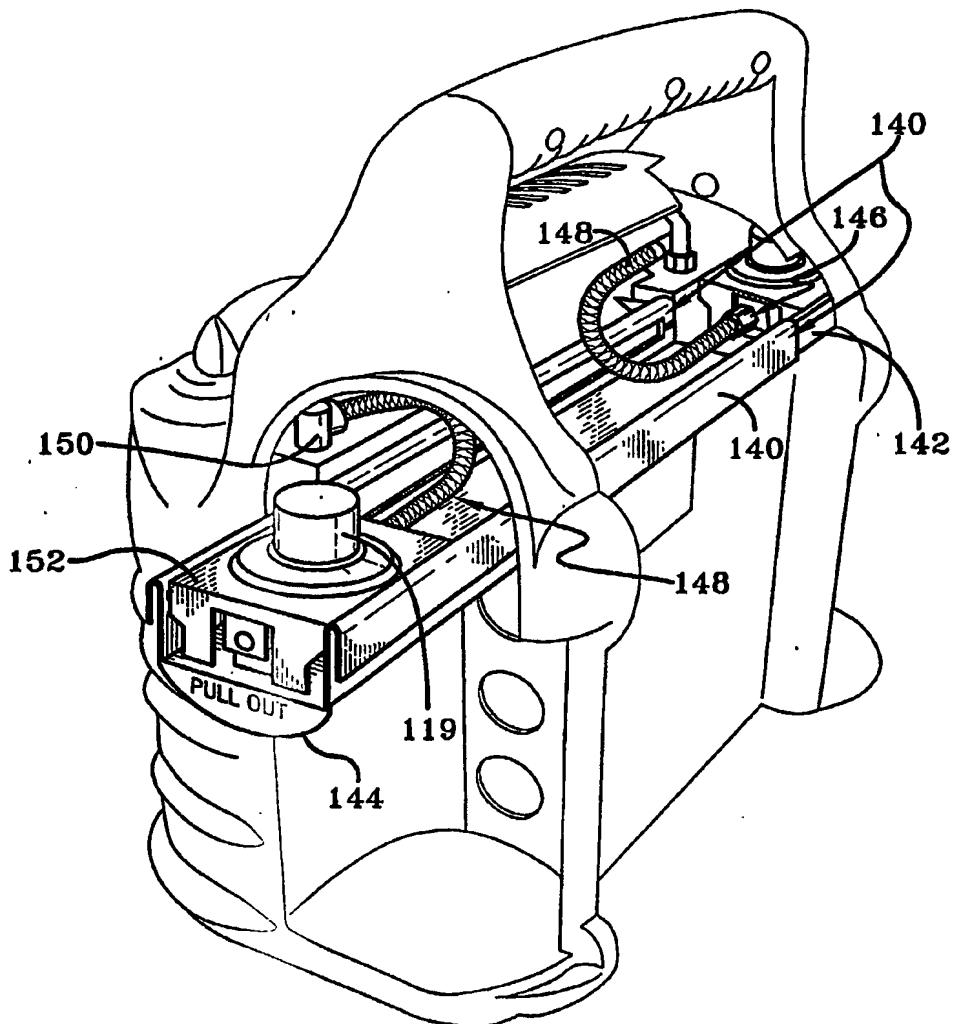


FIG-28

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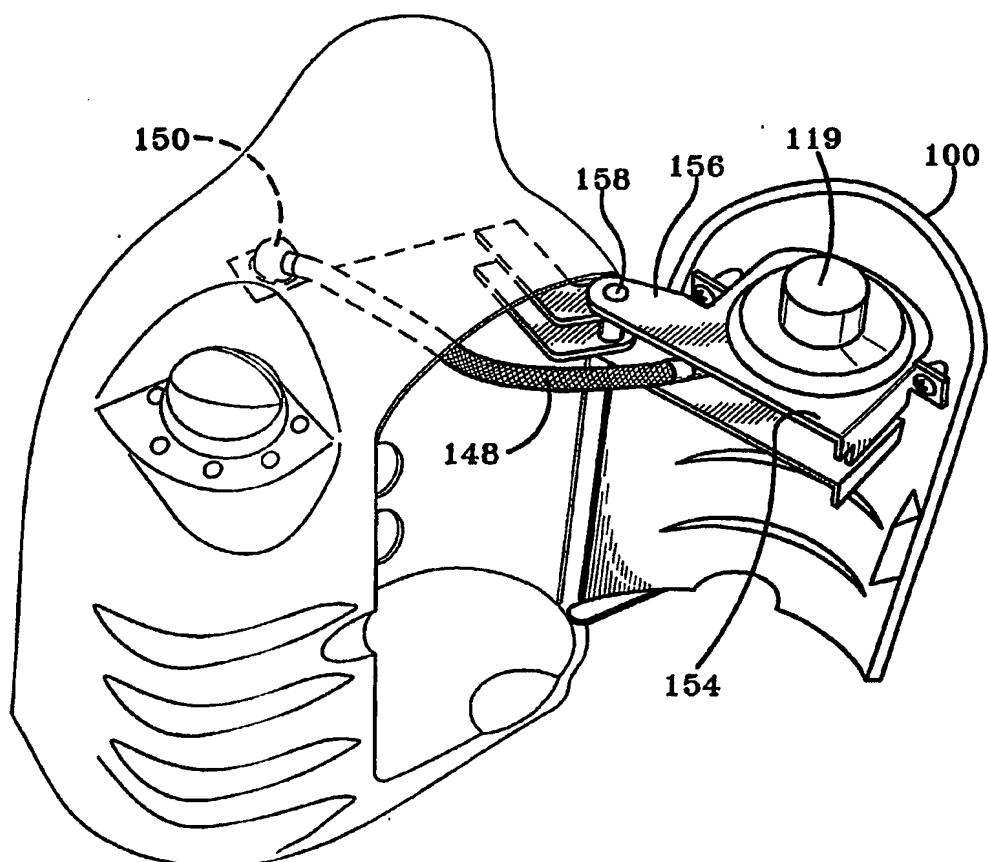


FIG-29

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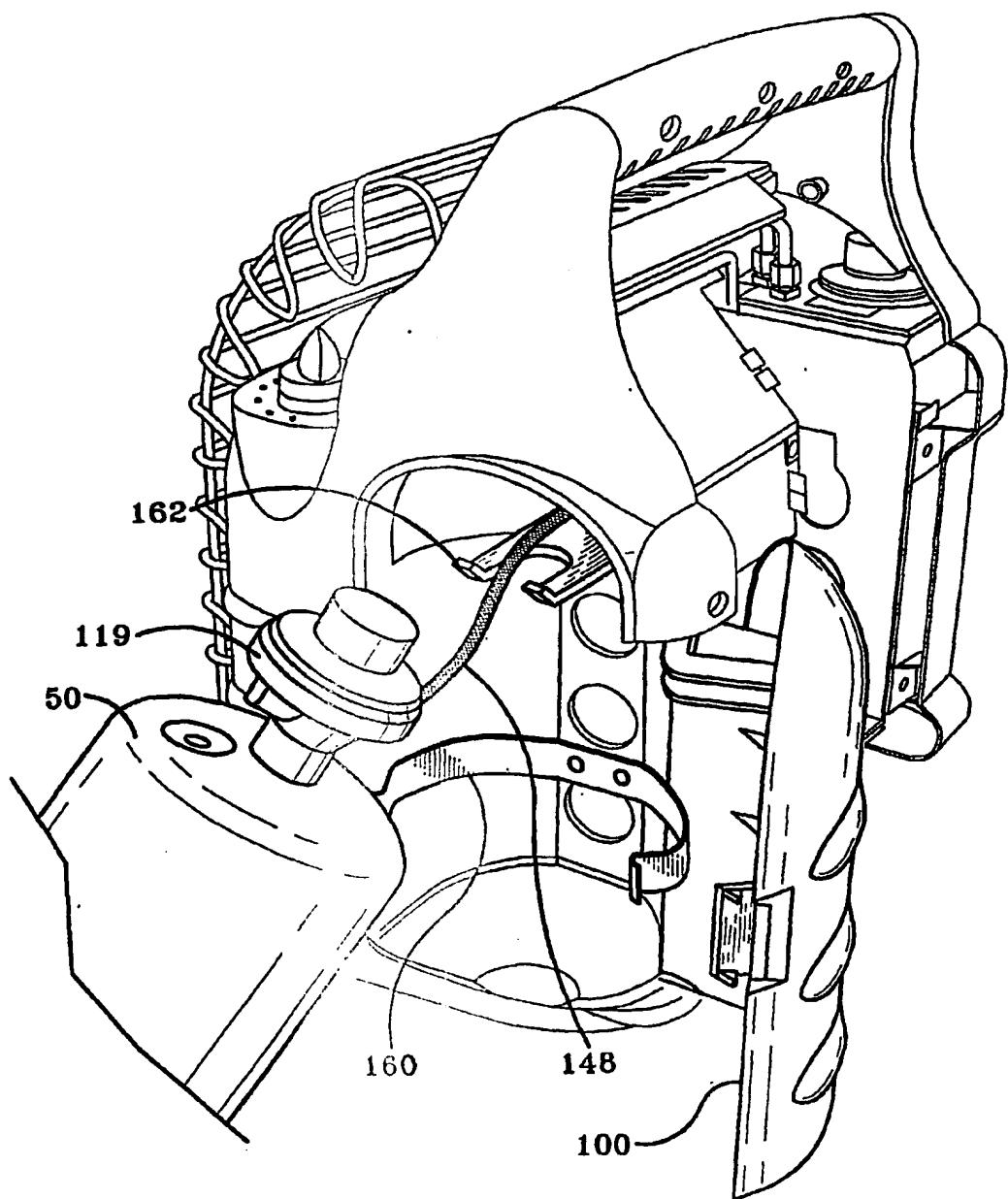


FIG-30

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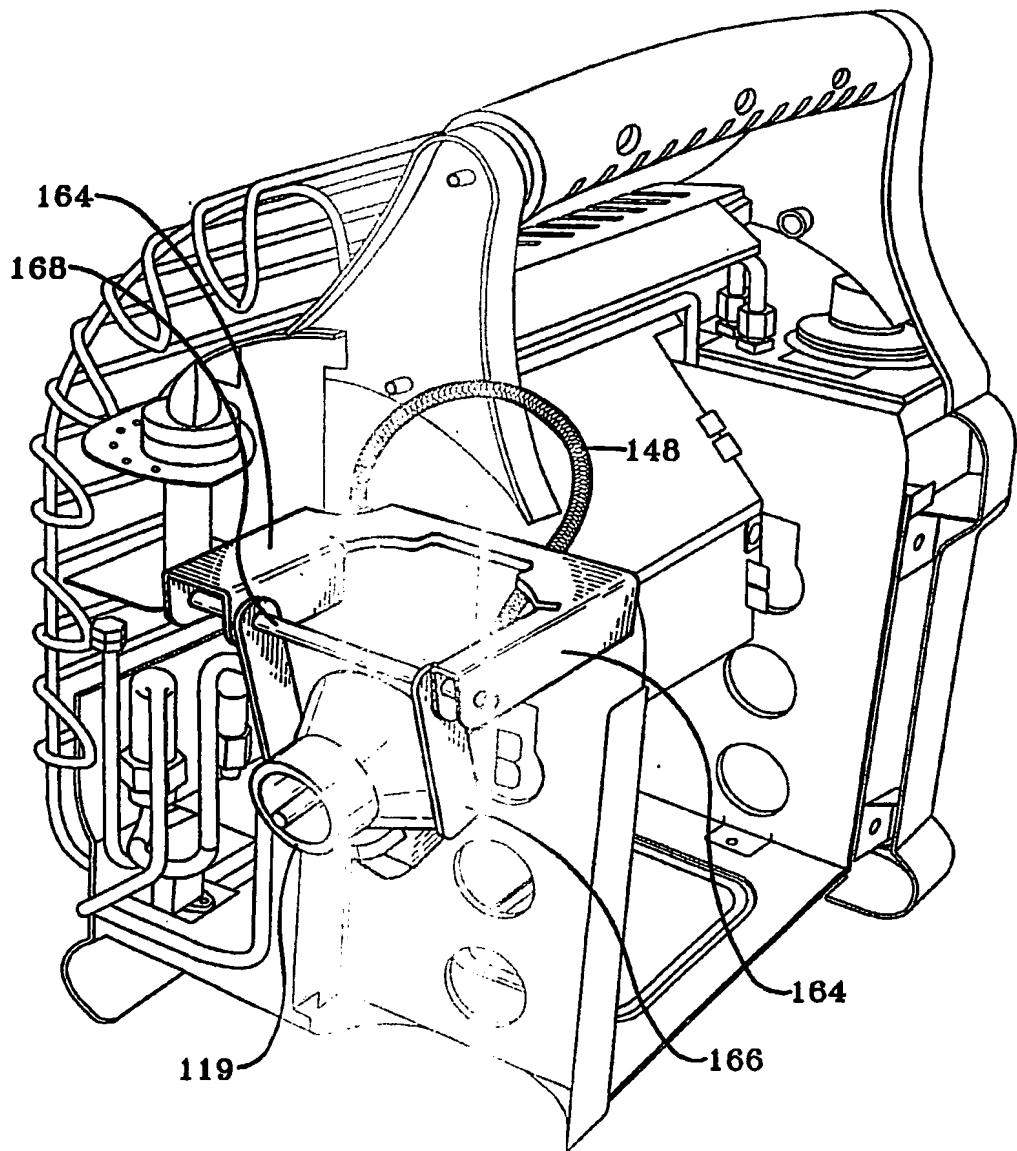


FIG-31

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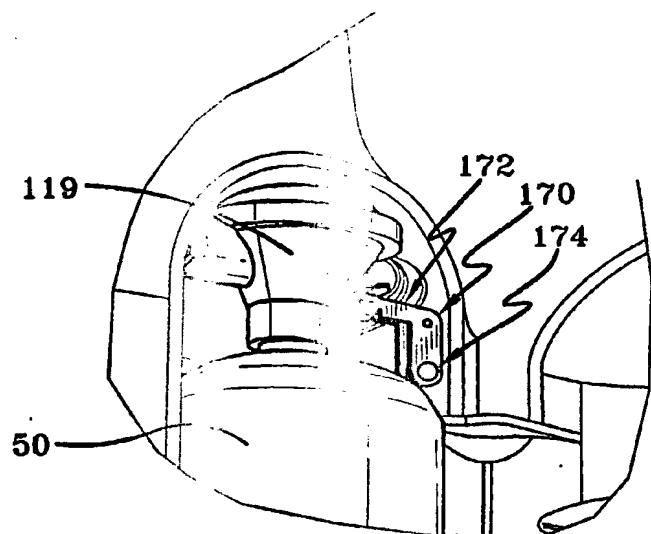


FIG-32A

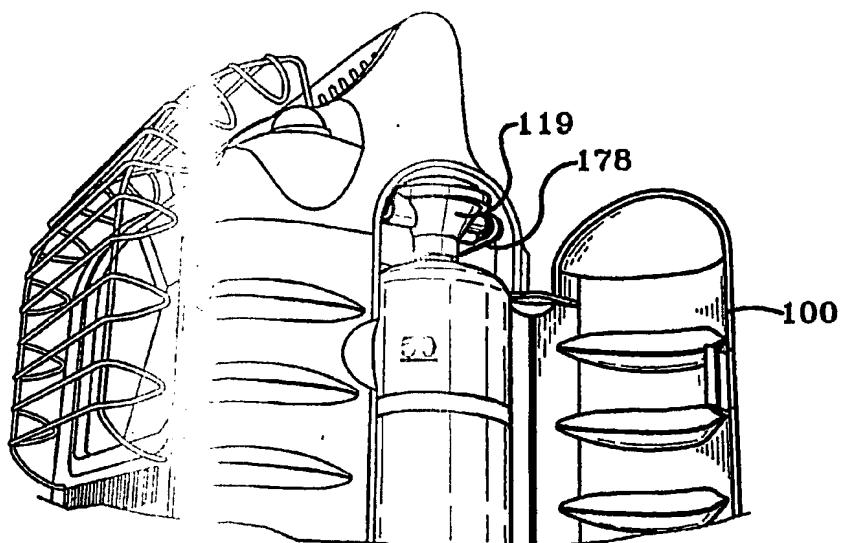


FIG-32

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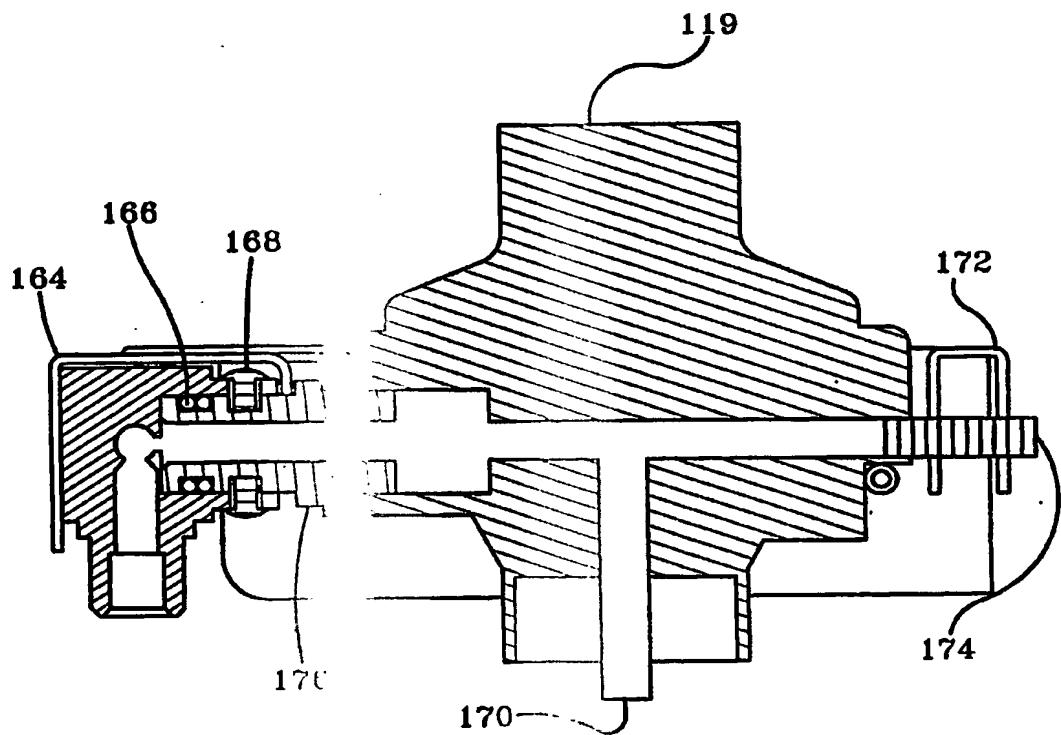


FIG - 33

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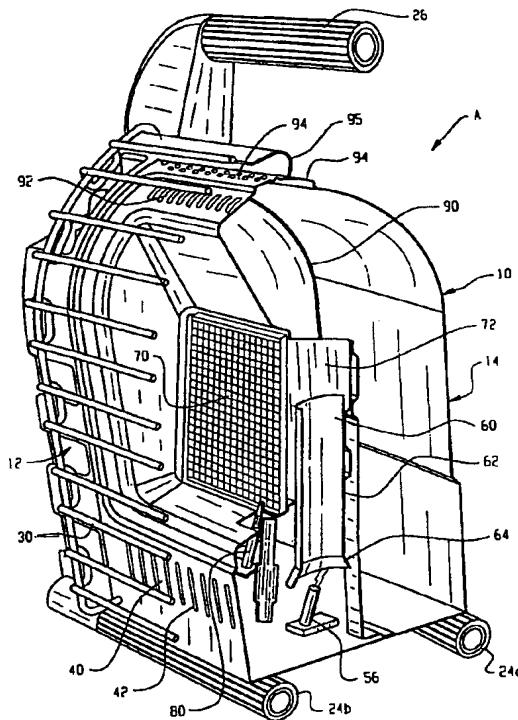
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- (30) Priority Data: 10/605,486 2 October 2003 (02.10.2003) US (Continued on next page)
- (63) Related by continuation (CON) or continuation-in-part (CIP) to earlier application:
US 10/605,486 (CIP)
Filed on 2 October 2003 (02.10.2003)

(54) Title: GAS FIRED PORTABLE UNVENTED INFRARED HEATER



(57) Abstract: A portable heater (A) adapted for use in a recreational enclosure or temporary work enclosure includes a housing (10) having an air inlet (40) on the lower front face. A gas supply (50) is at least partially enclosed by the housing which provides propane to the mouth (64) of a burner venturi (60) located within the housing. Air is drawn through the air inlet and also enters the mouth of the burner venturi. The air and gas are mixed thoroughly as they travel upwardly through the burner venturi. A chimney effect increases fresh air flow velocity into the burner venturi and allows the heater to operate at a reduced fuel gas pressure. Upon exiting the burner venturi, the air/gas mixture is to a plenum (72) and radiant surface (70) where combustion takes place.

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A. CLASSIFICATION OF SUBJECT MATTER

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B. FIELDS SEARCHED

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U.S. : 432/219, 222, 223; 126/92AC, 92B, 91R, 104A, 110A, 110B, 110C; 431/261, 80, 328, 345

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 354116747 A (TANAKA et al) 01 September 1979 (01.09.1979), See entire document	1-12, 17, 18, 24, 25, 27-34, 38-41, 47, 48, 50-56, 68, 69, 75, 76, 78-82
Y	US 4,782,814 A (CHERRYHOLMES) 08 November 1988 (08.11.1988), See Figures 1-3	1-12, 17, 18, 24, 25, 27-34, 38-41, 47, 48, 50-56, 58-63, 68, 69, 75, 76, 78-82
A	US 3,814,573 A (KARLOVETZ) 04 June 1974 (04.06.1974), See entire document	1-94
A	US 4,848,313 A (VELIE) 18 July 1989 (18.07.1989), See entire document	1-94
A	US 5,848,585 A (LONG et al) 15 December 1998 (15.12.1998), See entire document	1-94

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